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Morrin's "Climax" Steam Generator.

This steam generator is illustrated in Figs. 1 and 2, on this and the succeeding page. The lower portion of the right-hand side of Fig. 1 represents a section through the center; and the upper portion of the same side represents simply a part of the outer casing removed, exposing to view a number of the tubes. The left-hand side, with the exception of a very small portion, represents the outer appearance of the generator. Fig. 2 represents a horizontal section. Similar letters in Figs. 1, 2 indicate the same parts.

A casual glance may give the impression that this generator is very complicated; but a close examination will reveal it to be one of very simple construction; and when its construction is understood it will also be apparent that, with the ordinary amount of care, such as is generally bestowed upon common boilers, it is not liable to get out of order, and when, through constant use, repairs are demanded, they can be easily and quickly made.

The generator proper consists simply of the loop-like tubes *T*, and a vertical cylinder *A*, extending throughout the whole height of the generator, as shown in Figs. 1 and 2.

The construction of the cylinder *A* is similar to that of any ordinary cylindrical boiler shell; that is to say, it is made perfectly steam-tight, also strong enough to resist the internal pressure, and is provided on top with the usual manhole plate.

A better idea of the form of the loop-like tubes *T* may be obtained by referring to the shaded tubes in Fig. 2. The extremities *E* and *F* of these tubes extend, and are expanded into the shell of cylinder *A*, so as to make them perfectly steam-tight; their ends *F*, *F* are in higher planes than their ends *E*, *E*, as will be seen by referring to the lower shaded tube in Fig. 1.

Within the cylinder *A* there is arranged another cylinder *B*, whose upper end is open, and its lower end closed. The bottom of this cylinder rests on brackets riveted to the outer cylinder, and the upper end of cylinder *B* extends about up to the water line. The cylinder *B* is in fact a built-up one; it is made in short sections, so that they can be readily removed when repairs are necessary. Since the inner pressure of cylinder *B* is equal to its outer pressure, it is made of comparatively light iron. The joints of the sections need not be steam-tight, and consequently they are held together simply by means of a few bolts. In Fig. 2 it will be seen that the lower ends *E* of the tubes *T* are connected to the inner cylinder *B* by short tubes *C*, crossing the annular space *R*, *R*. These short tubes *C* are simply driven into the tubes *T*; their other ends rest in the holes through the cylinder *B*. The ends of the short tubes need not be, and are not expanded, as perfect steam-tight joints are not necessary.

The fire-box *V* surrounds the cylinder *A*, and is annular in form. The casing, *U*, *W*, is made in sections, bolted together.

This arrangement allows any one of the sections, such as *X*, for instance, to be removed without disturbing the other sections, when it is necessary to replace a tube. Sometimes the inside of the casing is lined with terra-cotta; in such cases the inner plates for the refractory lining shown in the illustrations are not used.

The action of the steam generator will be easily understood. The water, as it is heated, will ascend in the loop-like tubes *T*, flow into the annular space *R*, and a fresh supply of water is drawn from the inner cylinder *B*. In this manner a constant circulation is maintained in the tubes *T*, causing the steam and water in the annular space *R* to ascend and the solid water in cylinder *B* to descend.

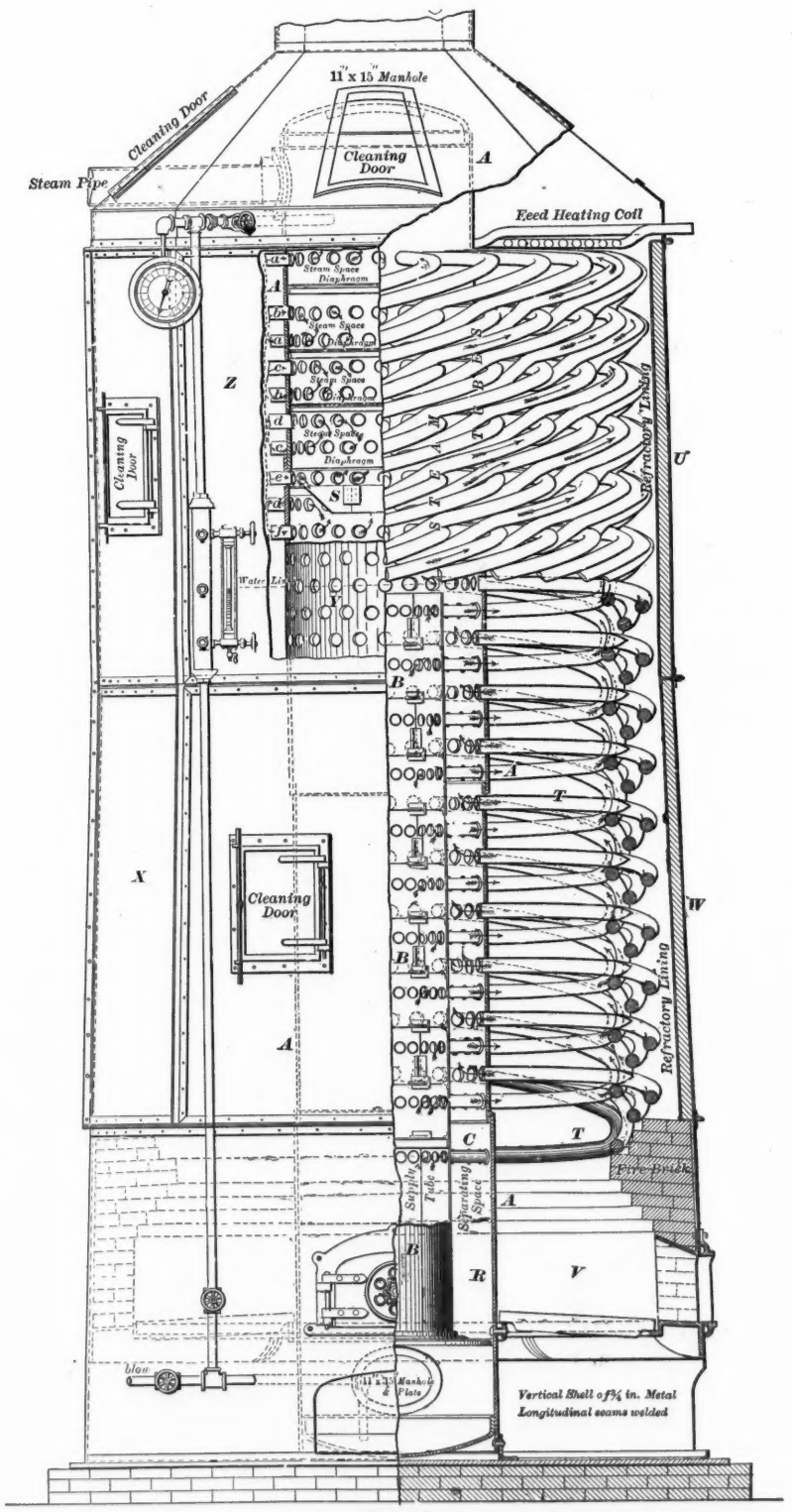


Fig. 1.

THE "CLIMAX" STEAM GENERATOR.

The deflector *S*, directly above cylinder *B*, tends to deposit any water that may be carried by the steam. The tubes above the water line will dry and superheat the steam; the diaphragm plates above the deflector compel the steam to circulate, in succession, through each tier of the steam and drying tubes.

The feed water in entering the generator has to flow through the coil resting on the upper tier of tubes, and is well heated before it mingles with the water in the generator.

In Fig. 1 a stationary grate is shown. With this kind of grate three or four fire doors may be necessary, but a rotary grate may be used, such as is shown in Figs. 3 and 4. With this kind of grate one fire door will be sufficient. The rotary grate may also be advantageously employed for an automatic feed. With a properly constructed hopper placed in front of the fire door opening, and the grate kept in motion by means of belt gear, the coal can be evenly fed over the whole grate with comparatively little trouble.

The grate shown in the illustration was not made for the generator shown in Fig. 1; the principles of construction of the grate are plainly shown, and further explanation is unnecessary.

The ratio of grate to heating surface in these generators is about 1 to 50. It will be seen that the heating surface is very effective, and consequently steam is very rapidly formed, and a high economy of fuel obtained. Another advantage is that, comparatively, very small floor space is required.

Since the largest diameter exposed to bursting pressure is the comparatively small vertical cylindrical shell, it will be seen that these generators can be made of large power and still be entirely safe under any pressure desired. When worked under ordinary pressures the factor of safety is high. Although these generators have been manufactured for general sale but a short time, it should not be inferred that they are untried. One of them has been under steam for three years, at Lorillard's factory, and shows no signs of failure anywhere; a tube recently cut out for examination was in as good condition as when first put in.

Several of them are now in use in electric light stations and other places, giving excellent satisfaction. The inventor and manufacturer is T. F. Morrin, chief engineer Lorillard's tobacco factory, Jersey City, N. J.

Expansion Joints in Steam Pipes.

BY W. H. BOOTH.

In a long length of piping it is absolutely needful to provide means for expansion, especially when the extremities of the length are fixed or are not desired to move. The insertion of a telescopic joint, which is simply a lengthened stuffing-box, is perhaps as good a method as any that can be adopted when applicable. It must not, however, be overlooked that the supports of the pipe ends are exposed to a pressure which they are often but poorly designed to withstand, namely, that of the steam pressure in pounds multiplied by the area of cross-section of the pipe. In a 12" pipe this product may be five tons, and it seems strange, considering the carelessness on this point that we do not hear of more expansion jointed pipes being blown asunder.

Examples may be seen where the steam pipe of a range of boilers passes close above each boiler, and without any springing length being interposed. In such cases expansion disks are to be seen between each boiler and its neighbor. The disks are made from dished circular plates of iron riveted round the edges and fitted with cast-iron flanged connections.

They are supposed to spring under the pressure of expansion, but are failures. In the first place, especially if of large diameter (and they are from 2 to 5 feet diameter), the steam pressure within them exerts a detrusive action, and may more than counteract their supposed and designed concertina action, and in the second place the lower part of the disk casing becomes filled with deposits from

priming, and the disk will split at the lower rivets.

Above a battery of boilers the main steam pipe ought never to be nearer than six feet of pipe from the junction valve, and this is far too little where there are many boilers. Thus, in a boiler-house of a Cheshire chemical works it is said there are now about 40 boilers in a row. At 11 feet per boiler a pipe of 420 feet would be needed to connect the whole. Now if one end of such a pipe were fixed it may be expected that the other end would vary in position about eight inches. This would be altogether too much for even a very long branch connection to accommodate, and in such a case telescopic connections would occur at intervals in the main pipe, which would require to be held firmly at each end and at its middle length. Indeed, a pipe properly fitted with expansion lengths ought to be held midway between each expansion piece, in order that each joint may be thereby compelled to move. Failing this, they have a tendency to stick fast, and all the motion is thrown upon the odd joint which works most easily.

Where expansion is neglected very serious straining makes itself visible even in a battery of four boilers, and the strain on boiler shells must often be enormous from this cause, and as frequently uncomputed. My own experience is decidedly in favor of the stuffing-box type of expansion joint, and utterly against the disk principle.

The facts noted by D. W. L. (American Machinist, Feb. 14,) are interesting, but only prove how severe stresses may be rendered invisible by a certain method of construction. The stresses caused leaks in a different method of attachment by wrought-iron nozzles, but they were equally present all the same even when the use of cast-iron nozzles prevented visible manifestations of them. The conclusion to be drawn is not favorable to a mode of connection which lends itself to the concealment of defective design or of neglect of essential principles. The stiffness and rigidity of cast-iron is favorable to the behavior noted. The elasticity of the material is small, and failure, when it occurs, is not usually preceded by indications of weakness; hence the undesirability of employing cast-iron for at least the main portions of steam boilers. Though of small elastic range, it should not be overlooked that cast-iron stretches twice as much as wrought-iron for the same unit stress within the limits of desirable stress. Hence, where a stress has to be shared equally by cast and wrought-iron conjoined, the cast piece should have double the area of the wrought piece, in order that its unit stress may be one-half only, and the stretch of each piece identical. The stress will then be carried equally by the two materials. When cast-iron manhole mouthpieces are fitted to boilers they are often very heavy—so heavy that they will stretch under stress very much less than the wrought plates which they strengthen. The result is that they bear the whole stress, and if at all faulty in casting may break and throw all stress on the plate, which in its turn fails. Union of two similar materials may give strength, but the riveting together of two materials of different elasticity and strength is an invitation to disaster, in that dissolution is effected piece-meal. No sane man would attempt to suspend a load of two tons by a combination of a chain and a hempen rope, for he would know that the chain would have to carry the whole, as the resistance of the rope could not come into play until it had stretched many inches; and yet this is being daily practiced by boiler makers the world over, and shows a lack of knowledge of the properties of materials of construction that is deplorable.

Shop Notes.

Worcester, Mass., has grown to be such an extensive manufacturing place, and has so many shops which are well worth seeing, that it is about impossible to see them all during the necessary limits of a single visit, or to describe what may be seen within the space available in our columns.

At the Washburn machine shop, which is connected with and really forms a part of the Worcester Polytechnic Institute, there is much to be seen which is of interest, especially in the work which is done wholly or in part by the students who are pursuing courses of study in the Institute, and are required to spend a specified number of hours per week in the shops, working successively at wood work (including cabinet making and pattern making), forging, machine-shop work, and drafting, all of which is done in a very creditable manner. Besides the regular lines of work turned out for the market, which include cabinet work, drawing-stands, engine and speed lathes, screw machines, emery-grinding machinery, hydraulic elevators, presses and accumulators, with a great variety of apparatus used in the schools and colleges, each class in its senior year builds some tool or engine which is outside of their usual line of work, usually getting the drawings for this from the builder of the machine. Several well-known machines are to be seen in the shops that have been built in this way, and which, judging from a cursory examination, are very creditable pieces of work in every respect.

Corliss, Buckeye and Straight Line engines have been built, as well as various well-known machine tools. The shop is provided with a good equipment of tools and appliances, which are evidently well taken care of. The tool-room, in which the regular check system is used, has a complete set of Whitworth gauges, to which all work is made to conform. At present there is being built an upright compound engine, of Prof. Alden's design, which embodies some new features and will be used for experimental work in steam engineering.

They have also under way a new engine lathe of original design. Near the machine shop there is a new building nearly completed, which is the gift of Stephen Salisbury, M.A. (who is a member of the board of trustees), and is to be used for a chemical and physical laboratory. It is 100x145 feet, four stories high, and is being very finely finished and fitted up with all necessary conveniences. A Babcock & Wilcox boiler is already in place, and facilities are to be provided for the testing of engines, as well as a large variety of other engineering work. The Institute, with the shops and this new laboratory, will be very well equipped for giving to young men a practical and valuable course of study. The citizens of Worcester generally are evidently quite proud of it, and the work it is doing, and have good reason to be.

The shops of the L. W. Pond Machine Co. are devoted exclusively to the production of planers, nothing else whatever being built in them.

The present shops are considerably crowded, and not the best adapted to the business, but they are building a brick addition three stories high, which, when completed, will greatly improve their facilities for getting out work.

In this shop is to be seen the longest planer in New England, the bed being 70 feet in length. At the time of our visit the bed of a large planer, to go to Cincinnati, was being planed upon it. This bed was 50 feet long, and the planer is to plane 72″ wide and 66″ high. It will be very heavy, the cross-rail, stripped of all other parts, weighing alone 2,400 pounds. Lying on the floor, waiting to be planed up, were two castings, which are to be used in the construction of one of the new lathes for the government, the contract for which is held by the Newark Machine Co. These castings resemble the bed of an ordinary lathe, but are to be placed side by side at some distance apart, and connected by suitable girders to form the bed. They weigh 11,790 and 12,800 lbs. respectively, and were cast at the Star foundry in Worcester, partly, we presume, with a view to saving the trouble and expense of transporting them to and from the planer.

The shop in which the Wheelock engine is made has changed hands, and is now owned by Messrs. Hill & Tolman, who are introducing improved methods of manufacture, as well as some minor improvements in the details of the engine They are very much crowded, and expect soon to move into new and larger quarters.

Among the other ingenious devices seen there was a pair of boring bars used for shaping the guides, which are circular in form but are bored to a circle, the radius of which is much less than that of the cylinder and much less than the distance from the center of the piston rod to the guides. They accomplish this by means of two bars, which are held in suitable frames, within which they can be adjusted to secure the exact distance apart required and precise parallelism. These are secured to the bed of the engine, adjusted to the proper position, and the guides shaped up by cutters which are in sliding heads fitted to the bars, the latter being driven by power. Thus both guides are bored at once rapidly and with great accuracy.

At W. C. Young & Co's. shops they are quite busy, principally upon their small speed and engine lathes, which are sold mostly to dealers and go mostly into the hands of amateurs. The problem here is to furnish a lathe sufficiently well built to give satisfaction for the purpose intended, and at a price which will insure large sales. It is solved largely by the use of special fixtures, jigs and milling machines, some of the latter having been recently added to the equipment.

At Prentice Bros. they have recently been adding to their equipment of tools, and have a well-developed system of producing interchangeable work, especially in the building

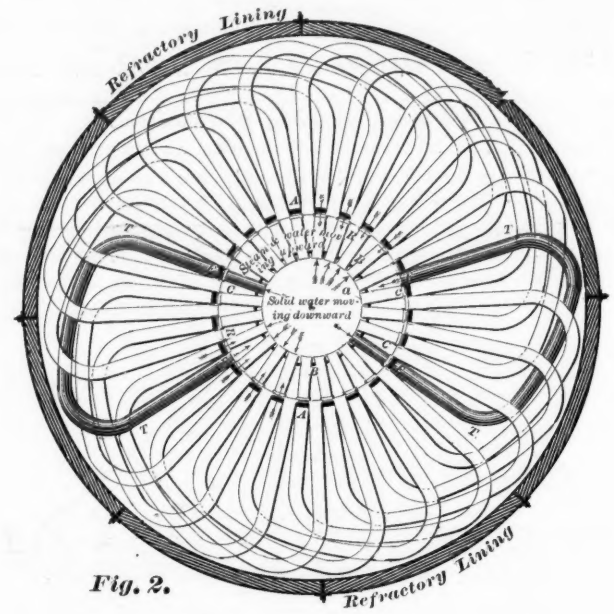


Fig. 2.

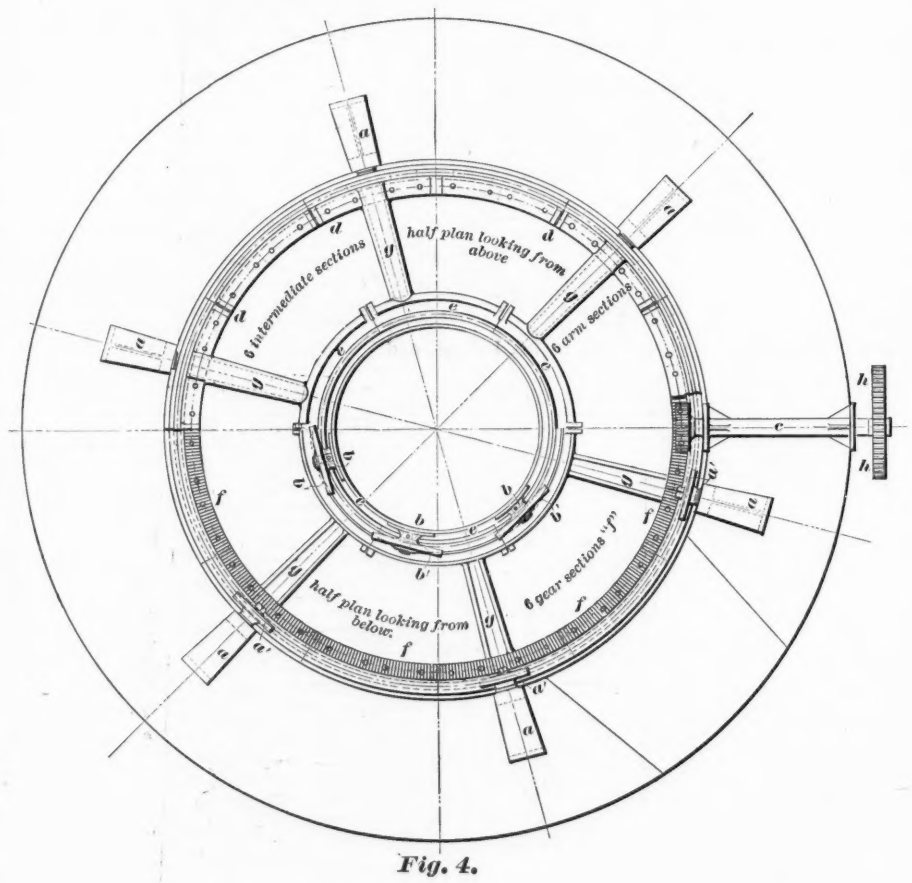


Fig. 4.

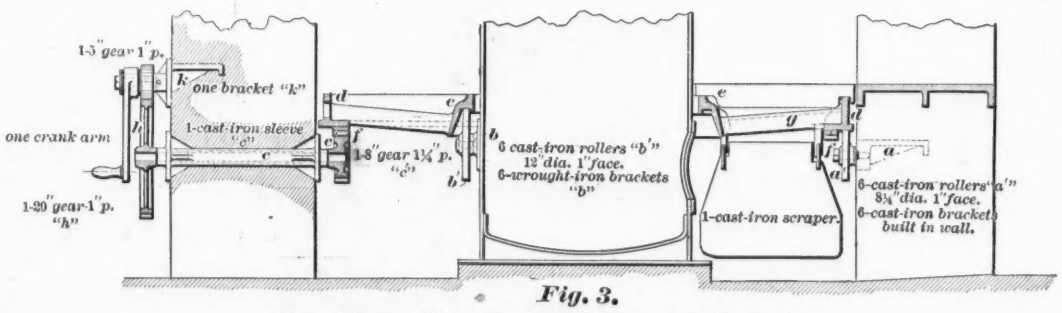

1-5" gear 1" p.
one bracket "k"
one crank arm
1-cast-iron sleeve "e"
1-8" gear 1¼" p. "c"
1-20" gear 1" p. "h"
6 cast-iron rollers "b'" 12" dia. 1" face. 6-wrought-iron brackets "b"
1-cast-iron scraper.
6-cast-iron rollers "a'" 8¼" dia. 1" face. 6-cast-iron brackets built in wall.

Fig. 3.

The "Climax" Steam Generator.—See Page 1.

of their drill presses, of which they manufacture large numbers, any part of any drill press interchanging without trouble. Some tests which we were permitted to apply to some of the presses in course of construction showed admirable results in respect of accuracy. The shops are roomy, well lighted, cleanly and in good order.

The Powel Planer Co., though they moved into their present quarters to secure more room, not long since, have again outgrown them, and are contemplating the leasing of larger shops which are already built, and are available, on the acceptance of the proposition of a capitalist who proposes to erect for them shops constructed upon the same general plan as those of the Pond Works at Plainfield, N. J. This shop also devotes its entire energies to the production of planers, nothing else being built. Jigs are used in getting out all the small parts, Mr. Powel giving some instances going to show the great reduction in cost possible by this method, aside from the advantage of having more uniform, interchangeable and generally better work. In one case the cost of the labor upon a certain part was reduced from $13 to $3, and the quality of the work at the same time improved. Although to a tool maker accustomed to the construction of jigs and other special appliances, these figures are not astonishing, we know of many shops where they should be very suggestive. The method of keeping account of cost followed in this shop differs from any other which we have noticed. The smaller parts of the planers are gotten out in considerable numbers, and a workman, upon receiving the castings or forgings for a lot of them, receives with them a ticket upon which their cost up to that point is noted. On this ticket his time is noted, and when the pieces are finished their actual total cost is written on a tag and attached to them, they being placed upon shelves in the stock-room, which is also the tool-room. When a machine is being built, and any of these parts are wanted, they are obtained by the erecters upon order of the foreman, he specifying upon his order the particular job for which the parts are wanted. The man in charge of the tool-room, upon giving out the parts enters their cost upon the order and puts it through a slot provided for the purpose just inside the tool-room window, when it goes into a box and constitutes a charge against the job to which it relates. When the job is complete the cost of the larger parts, and the erection, together with the aggregate of the cost entries upon these tickets, with a proper amount added for fixed charges, gives the actual total cost of the job.

Blaisdell & Co. have been for some time crowded with orders, and are evidently somewhat cramped for room. This firm is one of the pioneers in the construction of improved machine tools, especially our modern form of drill press, with its balanced spindle and quick-return motion, upon which they hold the original patents. They are about to bring out some new designs of drill presses and crank planers, and are putting in some improved tools to be used in construction, among which we noticed particularly a new turret head boring machine of their own design and construction, which will be used for general chucking and for boring the holes through lathe spindles.

Boynton & Plummer were found to be fairly busy, principally upon their well-known blacksmith drills, upon which they report a considerable and an increasing export trade, mostly with England and South America. They are also making a good many small shapers, having recently added to this machine a box pedestal in place of the legs upon which it was formerly placed.

Bits of Experience.

By PEDRO.

MARKING ON BLUE PRINTS.

It is well known to everybody acquainted with machine shop practice that frequent changes, more or less extensive, must be made on drawings by which any machine may be constructed. When blue prints are used, as they are in all shops of any note, such changes have been difficult, or at least unsatisfactory, whenever the marking agents used were black ink, alkalies, or Chinese white. Black on the blue background does not give a sufficient contrast to be easily read. Alkalies, though giving at first a somewhat white line, in a short time fade more or less, leaving a yellowish dirty mark, which neither looks well nor is easily read. The use of Chinese white is objectionable because it is not permanent—it is easily rubbed off unless fixed by varnish. But to varnish blue prints is poor economy.

The most satisfactory marking ink for blue prints known to the writer, and introduced by him into several shops, is the *red soda*. This consists simply of red ink, in which a little gum arabic and enough soda has been dissolved to decompose the blue coloring matter of the print. The relative amount of each is usually determined by trial. Red ink alone does not show much better on a blue print than black ink. The action of the soda solution alone is to decompose the blue matter of the print and leave the white paper exposed. This "white paper" is colored at the same time to any color desired, if the proper coloring matter be added to the clear soda solution. Diamond dyes answer admirably for this purpose. The gum arabic is added to thicken the soda solution, to prevent it from flowing too freely from the pen and spreading on the paper, which it is otherwise liable to do. Caustic soda is the best for the purpose, and is usually obtained from the druggists in small round bars. Ordinary washing soda, however, will answer.

A red ink thus prepared makes a bright contrast with the blue background of the print, and looks well. Any small alteration of a drawing may be drawn on the print with this ink without erasing the original lines, which can never be done well, and still the drawing is easily read, because the red lines are so prominent that they are not obscured in the least by the original lines. Of course, no extensive changes are made in this way, the blue print being replaced by a new one, made from the corrected "original," when it is cheaper to do so.

Any marking may be done on a blue print with this ink without the necessity of leaving a "white spot" to mark on, and then the red shows even better than the black on white.

ATTACHING LABELS, ETC., TO SMOOTH SURFACES.

The question is often asked, "How can labels be secured to bright metallic surfaces?" For this purpose the writer has often used shellac varnish (a solution of shellac in alcohol), and he has never seen anything so simple that would give as good results.

Stork had something better. One day a sheet-metal tray, divided into a number of apartments, was sent to a drawing-room to have some bank labels attached to each partition. The owner asked for information as to the best substance for this purpose, in answer to which a draftsman recommended shellac. But Stork, in doing the job, used his "superior photographic paste." Result: in about a week the tray was returned with all the labels gone—having dropped off one after another.

Shellac is not only good for metallic surfaces, but it adheres to glass equally as well, and, in fact, any surface as far as I know. I have used it as a glue for mending broken articles of wood, chinaware, glassware, etc. In many places it is superior to ordinary glue, as it is water-proof. Nothing better could be desired for mounting paper (such as drawings) on cardboard.

In applying this in practice, see to it, first of all, that the articles to be attached to each other are clean—free from grease or any oily matter. Put one coat of varnish on each surface to be brought together, and lay away separately to dry. Ten or fifteen minutes will be sufficient. Then put on a second coat, and after one or two minutes bring the two surfaces together with more or less pressure, and lay away to dry. In case of a label or drawing, a coat of the varnish should afterwards be put on the outside. This will protect it from moisture, and allows it to be washed when it becomes soiled.

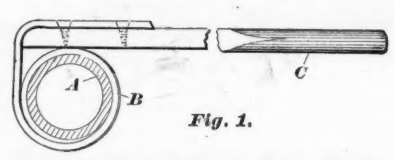


Fig. 1.

WRENCH FOR FINISHED PIPE WORK.

WRENCH FOR FINISHED PIPE WORK.

About fourteen or fifteen years ago I had a job which required some finished pipes to be screwed into threaded holes. The pipes had to be screwed up snug and the high finish of the pipes preserved. A pipe wrench could not be used on this account, and I found myself puzzled. A shop-mate helped me out of my trouble by explaining to me how to construct a cheap wrench which would fill the bill. This wrench is shown in Fig. 1, which shows its construction and the manner of applying it. *C* is a wooden handle made of a piece of board about one inch thick, and one and a half inch wide. *B* is a piece of leather belting nailed or screwed to the handle as shown. Holding the handle in the right hand and placing the belt around the pipe *A* with the left hand, as shown in the diagram, any pipe may be screwed up tight without in the least damaging the finished surface.

I believe a wrench for gas pipes has since been introduced, which is constructed on this same principle, with some modifications in its detail construction. In place of the belt I think a chain is used with flat links, having teeth on one edge—the edge which comes in contact with the pipe. The handle is appropriately made of iron.

Heavy Grinder.

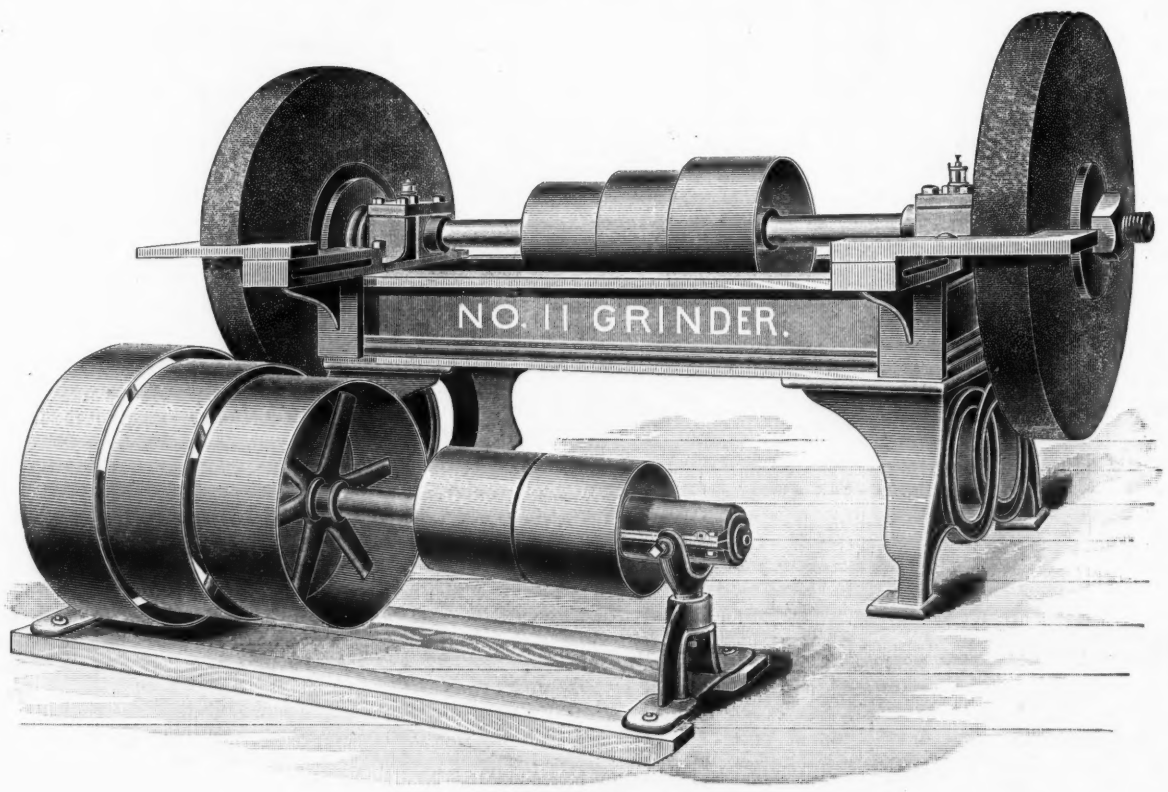
The cut shows a grinder recently brought out by the Union Stone Co., of Boston, Mass., which is specially adapted to railroad and similar heavy work.

In order to give ample room for two workmen to work at the machine at the same time, grinding large pieces without interfering one with the other, the spindle is made sufficiently long to bring the wheels 5′ 6″ apart. The spindle is 3″ diameter where the wheels go on, and is made of crucible steel.

The top of the bed is slotted all the way round, so that it can be built to suit the requirements of users, either as shown in cut, or with the shaft running crosswise of the bed, carrying a wheel at each end, or one large one in the center, like a grindstone.

When made in the latter form a long rest is provided, which reaches all the way across, and can be set on a bevel either way, making it very convenient in grinding beveled edges, and for a large variety of miscellaneous work.

The machine will take wheels up to 42″ x 5″, and has bearings 9″ long and 2¾″ diameter. There is a cone pulley on the spindle, giving three speeds, the largest step being 14″ diameter. Tight and loose pulleys on countershafts are 10″ x 8″. Weight of machine complete, 1,900 lbs.



HEAVY GRINDER.

On the new Pacific Railway to the foot of the Andes is perhaps the longest straight piece of railway in the world. It is 211 miles without a bend, and in this distance there is not a single bridge, and no opening larger than an ordinary culvert. There is no cutting greater than one meter in depth, and no embankment of a height exceeding one meter. There is practically no available timber on the plain, and this has led to the extensive use of metallic sleepers. Work has already been commenced on the mountain section of the road, which is to cross the Andes and unite with the Chilian line.—London *Engineer*.

Instructions by the British Admiralty are to the effect that more care must be taken in the use of forced draft. The appliances for creating draft are not to be used at full power except for brief periods in emergencies, and not, under ordinary circumstances, for the purpose of getting up steam quickly. All rapid changes in the temperature of boilers is to be avoided.

An English firm has been using petroleum for fuel in a torpedo boat, and getting a speed of 21 knots. The oil is carried in the vessel's double bottom. The boilers, it is said, steamed excellently.

Practical Drawing.

By J. G. A. Meyer.

SEVENTY-THIRD PAPER.

552. The sheet marked *C* (Fig. 447), and the head marked *D*, in the back connection, are laid out in a manner precisely similar to that adopted for laying out the plates *E* and *F*, as explained in the two foregoing problems. It will be good practice to work out the developments of these plates on separate sheets drawing paper. In laying out the plate *C*, follow the instructions given in Problem 83*a*; it should be remembered that the seam will be in the narrow part of the plate instead of the wide part as shown in Fig. 450.

In laying out the head *D*, follow the instructions given in Problem 83*b*.

Problem 83*c*.

553. To lay out the dome sheet, or, in other words, to find its development shown in Fig. 458, we must again draw, full size, on a blackboard, the preliminary outlines such as are shown in Figs. 457 and 457*a*.

Since the center line 6*n* 6*p* of the dome (Fig. 457) and the axis *x* of the shell lie in one plane, or, in other words, since the dome is placed centrally on the shell, we need to represent in Fig. 457 only one-half of the dome, and in Fig. 457*a* one-quarter of its circumference. In Fig. 457 the line 1*n*, 1*p* does not represent the outer surface, neither does it represent the inner surface of the dome, but it does represent the line drawn through the center of thickness of the plate; the line 1*n* 1*p* corresponds with the line *a b*, in Fig. 459, which simply represents on a larger scale a sectional view of the flange; this section is obtained by passing through the centre of the dome, a plane perpendicular to the axis *x* of the shell. It may also be mentioned here that Fig. 460 represents another section of the flange, obtained by passing through the center of dome a plane containing the axis *x* of the shell. To this figure we shall have to refer presently.

In our general plan of the boiler (Fig. 447) we see that the outer diameter of the dome is to be 20 inches, and the thickness of the sheet $\frac{5}{16}$ inch; consequently the diameter from center to center of the thickness of the dome sheet must be equal to $20-\frac{5}{16} = 19\frac{11}{16}$ inches; and one-half of this diameter, that is, the line 1*n* 6*n* in Fig. 457, must be equal to $9\frac{27}{32}$ inches. The arc *y* 6*p*, which represents the flange, is an arc drawn through the center of the thickness of the flange, and corresponds with the arc *c b*, in Fig. 459. The arc *v* v_2 represents the outer surface of the shell, consequently the distance between the arcs *v* v_2 and *y* 6*p* must be $\frac{5}{32}$ inch. These conditions must be kept in mind when we draw these outlines on the blackboard. To draw these outlines we proceed in the following manner:

Draw the vertical center line *x* 6*l* (Fig. 457), and also the horizontal line *x v*, intersecting each other in the point *x*. From the point *x* as a center, and with a radius of $20\frac{1}{4}$ inches, describe the arc *v* v_2; again, with a radius of $20\frac{1}{4}+\frac{5}{32} = 20\frac{13}{32}$ inches, describe the arc *y* 6*p*. At 18 inches above the point v_2 draw the horizontal line 1*n* 6*n*, and at $9\frac{27}{32}$ inches from the center line *x* 6*l*, draw the vertical line, 1*n* 1*p*, terminating in the horizontal line 1*n* 6*n* and in the arc *y* 6*p*. At any convenient distance above the line 1*n* 6*n*, draw the horizontal line 1*l* 6*m*, meeting the center line *x* 6*l* in the point 6*m*. From this point as a center, and with a radius of $9\frac{27}{32}$ inches, describe the arc 1*l* 6*l* terminating in the center lines *x* 6*l* and 1*l* 6*m*. Divide the arc 1*l* 6*l* into any number of equal parts, say five, and through the points of division, 2*l*, 3*l*, etc., draw vertical lines terminating in the arc *y* 6*p* and cutting the horizontal lines 1*l* 6*m* and 1*n* 6*n* in the points 2*m*, 3*m*, etc., and 2*n*, 3*n*, etc., respectively. The arc *g* 1*p* represents the width of the flange, measured on a line drawn through the center of its thickness. In order to determine the width *y* 1*p* we must examine the conditions in Figs. 459, 460. In these figures it is seen that the upper surface of the flange is to project $2\frac{3}{8}$ inches beyond the outer surface of the dome; and in order to obtain the width *y* 1*p* (Fig. 457), we must measure the lines *c b*, Fig. 459, and c_2 b_2 Fig. 460, drawn through the center of thickness of the flange. In measuring the lines *c b* and c_2 b_2, we find that the latter is slightly longer than the former; the reason for this is that, in Fig. 460, the flange is perpendicular to the dome, and in Fig. 459 it is not so; but the difference is small, and may be neglected. Therefore, to be on the safe side, we make *y* 1*p* equal to the greater width of flange measured on center line through the thickness, namely, equal to c_2 b_2; hence the width *y* 1*p* of the flange in Fig. 457 will be equal to $2\frac{3}{8}+\frac{5}{32} = 2\frac{17}{32}$ inches. This completes our preliminary views on the blackboard.

We shall now assume that the development shown in Fig. 458 is to be drawn directly on the plate which is to form the dome.

Near one of its edges draw the straight line *r*, r_2. On this line lay off two points, 1*b* and 1*c*; the distance between these points must be equal to the product obtained by multiplying the diameter of the dome shown in Fig. 457, by 3.1416. This diameter is equal to $19\frac{11}{16}$ inches, or, in decimals, 19.6875 inches; hence, the distance from 1*b* to 1*c* must be equal to $19.6875 \times 3.1416 = 61.85+$, say $61\frac{7}{8}$ inches. Divide the distance 1*b* 1*c* into twenty equal parts; we say *twenty*, because one-quarter of the distance between 1*b* and 1*c* is represented in Fig. 457*a* by the arc 1*l* 6*l*, and this arc has been divided into five equal parts; therefore 1*b* 1*c* must be divided into four times as many equal parts. Through the points of division 2*a*, 3*a*, 4*a*, etc., draw vertical lines. Now assume that the center of the seam is to be on the line 1*n* 1*p*. Under these conditions, we must make the line 1*b* 1*j* (Fig. 458) equal to 1*n* 1*p* (Fig. 457); 2*a* 2*j* equal to 2*n* 2*p*; 3*a* 3*j* equal to 3*n* 3*p*; and so on in succession, as indicated by the numbers prefixed to the letters. Through the points 1*j*, 2*j*, 3*j*, etc., draw a curve and thus complete the outline of the shaded surface, which is the developmnnt of the dome sheet without any allowance for the flanges and lap.

The vertical seam on the dome is to have $2\frac{1}{8}$ inch lap; hence, outside of the shaded surface at $1\frac{1}{16}$ inch from the line 1*b* 1*j* draw the line *r s*; also at $1\frac{1}{16}$ inch from the line 1*c* 1*j* and outside of the shaded surface draw the line r_2 s_2. From the points 1*j*, 2*j*, 3*j*, etc., as centers, and with a radius equal to *y* 1*p* ($2\frac{17}{32}$ inches), describe short arcs similar to

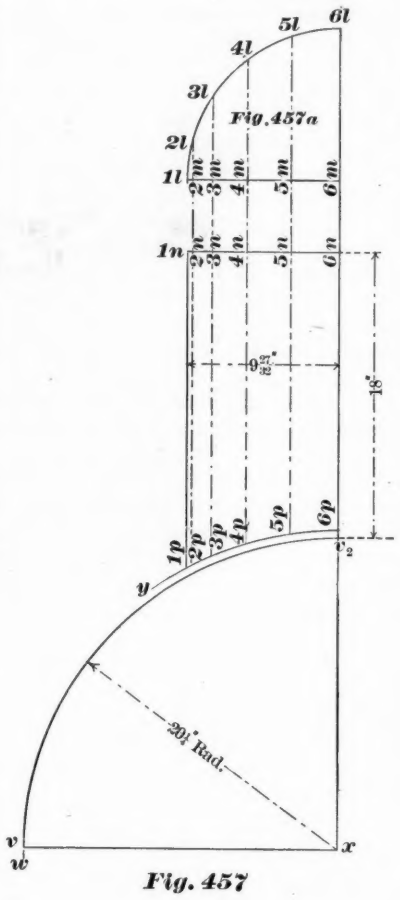


Fig. 457

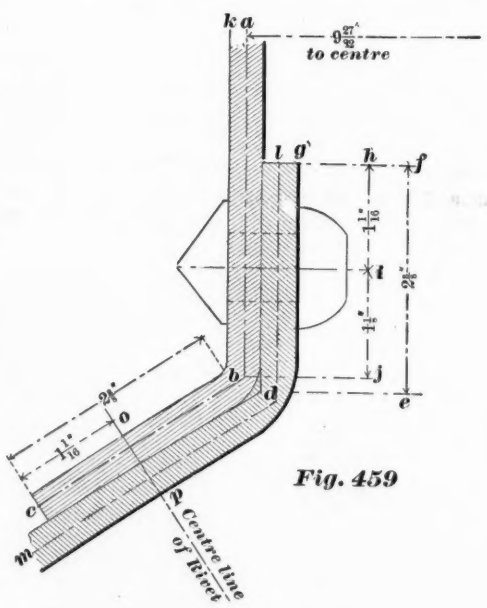


Fig. 459

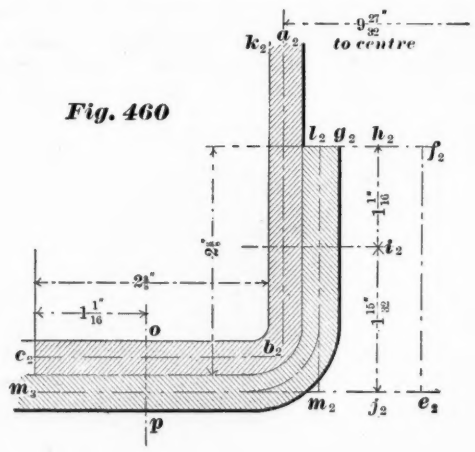


Fig. 460

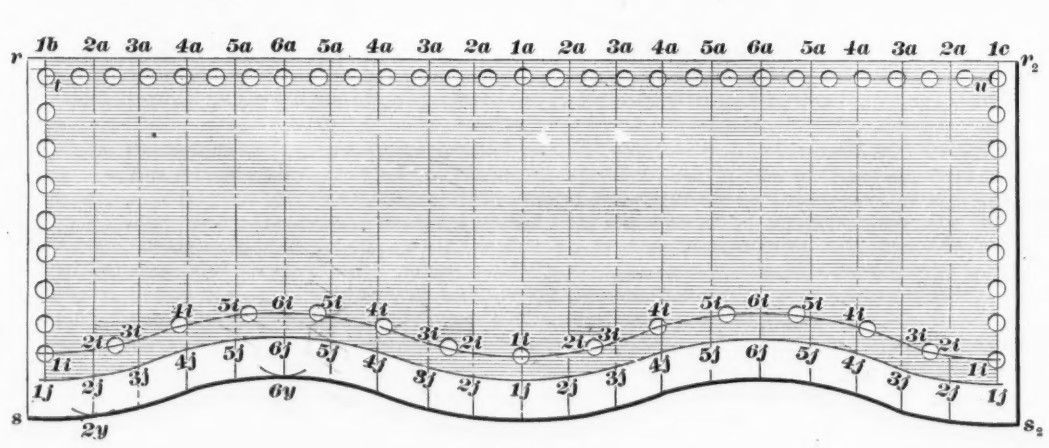

1b 2a 3a 4a 5a 6a 5a 4a 3a 2a 1a 2a 3a 4a 5a 6a 5a 4a 3a 2a 1c
r
r2
t
u
2l 3l 4l 5l 6l 5l 4l 3l 2l 1l 2l 3l 4l 5l 6l 5l 4l 3l 2l 1l
1j 2j 3j 4j 5j 6j 5j 4j 3j 2j 1j 2j 3j 4j 5j 6j 5j 4j 3j 2j 1j
6y
s
2y
s2

Fig. 458

rolled to its proper form, and the centers of rivets in the vertical seam will lie in these lines.

The rivet holes in the flange, that is, in the space between the curves 1*j* 6*j* 1*j* and *s* 2*y* 6*y*, must be marked off after the flange has been turned, and, therefore, no attention need to be paid to the position of these holes in laying out the plate. But in some cases it may be desirable, before the sheet is rolled, to mark off the holes for the rivets shown above *b*, in Fig. 459. In this figure we see that the center of this rivet is $1\frac{1}{2}$ inch above the point *b*; and in Fig. 460 we find that the distance between the corresponding point b_2 and center of rivet is somewhat greater, it is $1\frac{5}{32}$; this slight difference, which is caused by the unequal angles formed by the flange and dome, may be neglected. Hence, from the points 1*j*, 2*j*, 3*j*, etc. (Fig. 458), as centers, and with a radius equal to $1\frac{5}{8}$ inch, describe short arcs, and tangent to these arcs draw the curve 1*i* 6*i* 1*i*, which will be the center line of rivets along the curved edge of plate. The points 1*i*, 1*i*, in which this curve meets the lines 1*b* 1*i*, 1*c* 1*i* will be the centers of the extreme outer rivets on this curve; and the points *t*, *u*, in which the line *t u* meets the lines 1*b* 1*i* and 1*c* 1*i* will be the centers of the extreme outer rivets on the line *t u*. Therefore on the line *t u* lay off, in succession, points which are $2\frac{1}{8}$ inches apart, or as near as possible to $2\frac{1}{8}$ inches, so as to make all these distances on the line *t u* equal to each other. In a similar way lay off the centers of rivets between *t* and 1*i*, and also between *u* and 1*i* on the lines *t* 1*j* and *u* 1*j* respectively.

The distance between the centers on the curve 1*i* 6*i* 1*i* is usually equal to twice the distance between rivets on the line *t u*; hence, on the curve 1*i* 6*i* 1*i* lay off points $4\frac{1}{4}$ inches apart, or as near as possible to $4\frac{1}{4}$ inches so as to make all spaces between the rivets equal to each other.

The plate, before it is rolled and flanged, must be cut to the straight lines *r* r_2, *r s*, r_2 s_2 and the curve *s* 2*y* 6*y* s_2.

The amount allowed for flanging is the least which should be allowed. Since it is often a difficult matter to turn the flanges very accurately, it may be desirable to allow a larger amount for flanging; for determining this increased amount the boiler maker must use his own good judgment.

Directions.—On one of the 20x15 inch sheets of drawing paper find the development of the dome sheet. This should be done after this paper has been carefully read, and the principles thoroughly understood, and should not be referred to in laying out the dome sheet. The only drawing which the student should keep in sight is the general plan, Fig. 447.

Use a 3-inch scale.

A Yorkshire coal dealer has hit upon one of the most novel, as well as most effective schemes for advertising, of the present century. He has a weighing machine which gives over instead of under weight; and, although warned by the authorities that it was as illegal as the one that does the other thing, he persisted in its use until a fine of 5s. and costs resulted, the bench expressing the opinion that it looked a little hard to punish a man for cheating himself to benefit his customers. He paid the fine, and has the bulk of the coal business in his parts.—*Grocers' and Canners' Gazette.*

In a paper read before the Royal Society (England), Henry Hennessy, F. R. S., says the maximum discharge of water through a pipe of circular section, when the head is due only to the inclination of the pipe, is not when the pipe is full of water, but when filled to about nineteen-twentieths of its diameter.

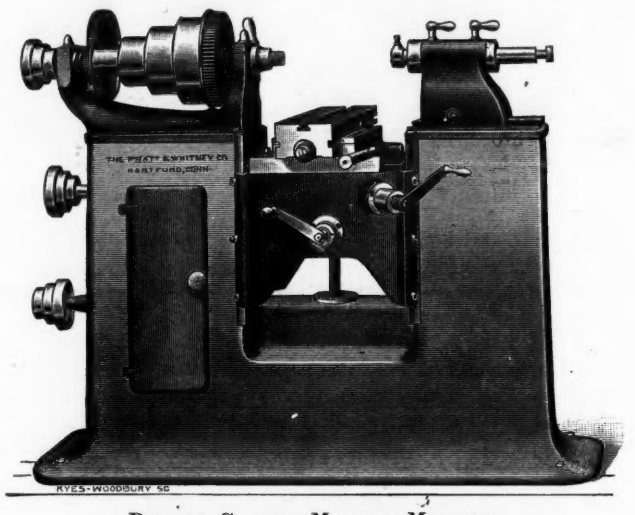
It is said that the exhibit of steam engines at the Paris Exposition will be the finest ever seen.

Grant's Double Column Milling Machine.

With this we illustrate a milling machine which was designed by Mr. John J. Grant, and is being now regularly manufactured for the market by the Pratt & Whitney Co., of Hartford, Ct. As will be seen, the general design of the machine consists of a heavy base extending under the entire machine, from which rise two columns which are cast solid with the base. On the inner faces of those columns, sliding surfaces are provided, to both of which the elevating block, or the part corresponding to the knee of the ordinary machine, is fitted and may be firmly clamped when in use. By this construction the two upright columns are firmly tied together at a point as near their tops as the height of the work being operated upon will admit of. It is thus seen that the maximum of rigidity is secured, and, as is well known to mechanics, rigidity is, in milling machine construction, nearly synonymous with efficiency.

The construction of the machine is very simple, and all the movements are effected by handles or cranks which are within easy reach of the operator. Both the vertical and longitudinal adjustments of the table may be varied minutely by means of graduations in thousandths of an inch, conveniently placed. The machine is powerfully geared, the ratio being 9 to 1. The cone takes a 2¾″ belt, the largest step being 10¼″ diameter. The front bearing of the head stock spindle is 3″ diameter and 5 inches long, and the screw thread on the end of spindle 2½″ diameter. The greatest distance between spindles of head and foot stock is 16 inches, and between the top of table, when at its lowest point and center of spindle, 12½″; travel of table, 16″; width of saddle, 18¾″; horizontal adjustment on elevating slide, 7½″. The machine has twelve changes of feed, eight speed changes and automatic screw feed, with stop motion.

Countershaft has tight and loose pulleys 12″ diameter, 3½″ face, and should make 200 revolutions per minute. The machine weighs, complete, 2 000 pounds.



DOUBLE COLUMN MILLING MACHINE.

Self-Instruction for Young Mechanics.

BY FRANK RICHARDS.

V.

It will be remembered that I am calling attention to isometrical projection for its value and applicability to sketching or free-hand drawing. The little illustrations that I offer, I make with instruments in the regular mechanical way, and that may be said to be rather inconsistent. But I am only trying to put *the idea* of isometrical drawing in a simple and familiar way, so that common, every-day, young shop folks will be able to get hold of it. The application of it will come readily enough to any one who once fully understands it; and it will come in play whether making working drawings with instruments or sketching with eye and hand unassisted.

We are now ready to make an isometric projection of a brick. Our brick, we need not remind any one, has three dimensions: length, width or breadth, and thickness or depth. Either dimension may be assumed for the vertical one. We can draw the brick as standing upon its side (Fig. 1), its edge, (Fig. 2), or its end (Fig. 3); and so the brick can be drawn in isometrical projection in three different positions, or, making them right and left, we can have six different views, using whichever may be most convenient. Strictly speaking, our brick can be drawn in any position, as, for instance, where it might occur in the setting of a boiler; but it will be better for us not to say anything about that now.

We can draw our brick first in what we may call its most natural position—lying upon its side. Then the lines running in the direction of its thickness or height, the corner lines, will be vertical. Lines that are vertical in the object to be drawn should always be vertical in the drawing. This law determines the direction of many lines of a drawing, without any further trouble, and it may usually be well to draw a prominent vertical line of an object for a beginning. The character of the object will decide that. Having determined the scale that we want to make our drawing to, we can draw the first vertical line *A B*, according to that scale. There is a scale of some kind to every drawing. When we set out to make a rough sketch of anything, we have some idea of how big we want the whole thing to be, and then, from the beginning, we make the parts of it of a size or length to correspond with our idea of the whole, and that is working to a scale in a rough and perhaps unconscious way.

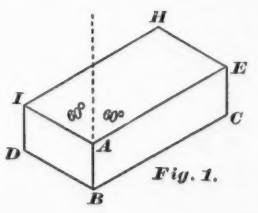


Fig. 1.

Fig. 3.

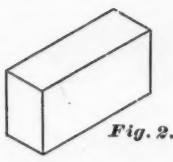


Fig. 2.

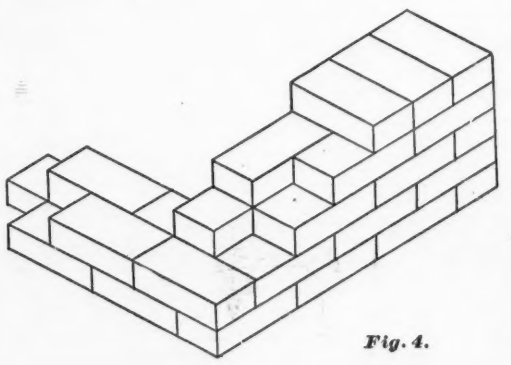


Fig. 4.

Now when we come to draw our next line we come to one of the peculiarities of isometrical drawing, and that is that straight horizontal lines in the object that stand square with, or at right angles to each other, are drawn in one or the other of two fixed directions. We draw the line *B C* for the bottom corner of the front edge of the brick. This line should stand at the angle of 60 degrees from the vertical line, and all lines in the brick running lengthwise of it, and that are parallel with the one represented in the drawing by our line *B C*, must be drawn parallel with that line, or they must all stand at 60° from the vertical line. Then the line *B D* for the bottom corner of the end of the brick must be drawn in a direction 60° the other side of the vertical line. In following the isometric system for free-hand drawing, it of course will not be necessary to determine either of these angles with any accuracy.

We have now the three lines *A B*, *B C* and *B D*. *A B* is already of the required length according to our scale. We now measure off the other two lines to the required length according to the same scale, and that brings us to the other peculiarity of isometric drawing, the peculiarity that is supposed to be described in its Greek and Latin name, the peculiarity that makes it peculiarly valuable for mechanical drawing. The peculiarity is that, differently from true perspective, all the rectangular lines, all the lines of a brick, in an isometric drawing are of their proper proportional length, according to the scale of the drawing. An isometric drawing is thus a correct, accurate and reliable working drawing, which a true perspective drawing can never be.

To complete our drawing of a brick no further measuring will be required. From the point *A* we draw *A E* parallel to *B C*, and *A I* parallel to *B D*; then the two vertical lines *I D* and *E C*; then *E H* parallel to *B D* and *I H* parallel to *B C* finishes the work.

That is all there is of it, and there is nothing terrible about it. Anybody can project a brick. And anybody that can project a brick on paper can draw any rectilinear rectangular figure. And now, you see, I am in trouble again. He will surely take fright at those two terrible words. I mean that, as far as we have got now, you can draw anything that is made of straight lines that are parallel to or square with each other. If you only had the nerve you could even draw a parallelopipedon. But that is too much to hope for. You never can tell just what will frighten a fellow. I know I can use the word *parallel* with perfect safety; for it is a curious fact that that one word will not frighten a machinist, while many a simpler one will. The word *plane* is one that he wrestles with as much as with any, I suppose, and the poor unfortunate usually gets thrown. The machinist can never produce a plane surface; the nearest he can come to it is to get it "out of wind." To imagine a plane and two points or lines lying in it, is too much to ask of him. I do not know how I could do machinists a greater service than by helping to reveal the disguised simplicity of some of the things that surround him, to take the frightful look away from them, so that a fellow can face them without fainting away.

As I was saying, we can now make an isometric projection of anything that is made of parallel lines and right angles. Where oblique lines and circles come into the case we will have a little more trouble, and we will not say anything about it to-day. We will exercise what we have so as to fasten it. If you can draw one brick you can draw several, and I have piled up a few here (Fig. 4) that ought to make a good exercise. You can find plenty of real models around the shop, and they will be of use to you if you use them.

A good recent practical example of isometric drawing is the "Back for Blue Print Frames" in the AMERICAN MACHINIST, Dec. 15, p. 6. It is all rectangular work, and the dimensions of details being given, it would make a good drawing exercise. The scale in the paper is nearly, but not exactly, ½. It should be drawn much larger, say ¼ or ⅓ size. If you go to trying the angles don't be misled by the fact that the drawing is not quite true with the columns of the paper, but is turned, the top of it, a little to the right. It will be noticed that one set of the bars does not stand square, that is, they are not parallel with the end of the board. That, you will see, is because the ends of two of the bars were struggling for the same standing place upon the bar under them, and each pushed the other one-half its width out of the way. The bars are drawn with shade lines. The underside of the bar, also the right-hand side of the near end, is drawn with a heavier line. The heavy line is not continued where the bars are in contact, and it has the effect of making the bar look as if it was notched and fitted down over the other. I believe that is according to the general practice; but I can't say that I like it, you know.

Thoughts and Queries.

BY S. N. HARTWELL.

We often read in the local papers and the associated press dispatches accounts of terrible boiler explosions which wind up something like this:

The boilers were inspected six months ago, and were thought to be in first-class condition. The real cause of the explosion will probably never be known, as the engineer was killed outright, and no one else has been found who was in the engine room at the time the disaster took place.

This is a pertinent question: What if he, the engineer or boiler attendant, had escaped death and serious injury, is it probable that he would, even if he was capable of doing so, explain the cause of the explosion, thereby pleading guilty of the crime of manslaughter? Nobody believes he would either publicly or privately confess that he had been using a defective safety valve that required the strictest watching and care, to prevent it from fatally sticking to its seat, or that he had added grate bars or old junk to the load on the lever in order to bottle up a supply of steam, or that he had continued to use the old boiler after having weakened it by burning the crown sheet, or otherwise, so that it was known to be in a condition to give way like a rotten old garment on the occurrence of an accidental over-pressure or a slight shock from a sudden disturbance of the contained water. He might give us in self-defense the "lifting of the water" theory, meaning that the water from some unknown or not easily explained cause had left the fire-sheet, thus forming a cavity under the water and between it and the iron of the shell, filled with steam, which, suddenly condensed, had given the overheated and weakened line of plate a fifty-ton water hammer blow.

Suppose such a steam cavity were not impossible, and that the steam could be condensed suddenly enough, may we not theoretically suppose also that the water, charged though it is with disintegrating heat—nascent steam—would shoot across a vacuous space like semi-solid water, so to say? But if he is intelligent enough to explain such a theory he must know that he is giving us rotten trash. Cloudy as his theory may be, still the rush of cold "solid water" into a vacuum is something worth studying in this connection.

In the absence of an air pump and other laboratory tools which are commonly used for the production of the physicist's water hammer, let us take a vessel of the capacity of a large wash-tub, nearly full of cold water, and introduce vertically a half-inch steam pipe fitted with a common globe valve and connect with any convenient source of steam of common pressure, leaving five or six inches space between the end of the pipe and the bottom of the tub. Blow steam through the pipe a few seconds to heat the pipe, and close the valve, then at once slowly open the valve till just the right quantity of steam enters the cold water to produce the lowest obtainable reports. Very little steam will do it. Now place the naked open hand, with palm horizontal, under the pipe, low down at first, and move it slowly upward. The sensation produced when the palm is at the center of the supposed vacuous or steam-filled space, will surprise if it does not please the experimenter, if he has not given the sub-

ect intelligent study. He may get a more decided shock by moving his thumb, held vertically the nail toward the pipe and on a level with the end of the pipe till the thumb nearly touches the pipe.

No harm will be done to the hand either by shock or heat, but a pretty strong hint may be obtained as to the cause and effect of the common steam-fitter's water hammer, which is so trying to delicate nerves. To continue, take a long-handled tin dipper of two quarts capacity; fill it with cold water and let the steam similarly into the water, move the dipper about, up and down and horizontally till the best effect is obtained, which may be found when the pipe nearly touches the side of the dipper or is within an inch or less of the bottom in its center. The practical engineer is generally familiar with these phenomena, still the subject may acquire new interest if he turns his thoughts, while observing, towards his condenser and air pump, and he will very likely vary the condition of the experiment by dropping some easily soluble coloring solid into the dipper and substituting a foot or so of clear glass tubing for a like length of his iron pipe, and so patiently vary the methods and conditions till the subject is clearly understood and the knowledge practically applied.

The searcher after occult or mysterious causes of steam boiler explosions will doubtless view things differently and find comfort in the thought that he is about to discover number one thousand and one panacea in the shape of a buffer, to be taken inwardly by any existing boiler, or that he is on the right track to the discovery of the long sought non-explosive steam boiler.

LETTERS FROM PRACTICAL MEN.

Moulding Crowning Faced Pulleys.

Editor American Machinist:

The accompanying cut represents a method of moulding in green sand, large crowning faced pulleys. After having secured the spindle—which is not shown—put on a sweep the required length, and strike off a level bed on which place ring *A A*, to admit of afterwards checking outside off. It will be seen by referring to Fig. 1, that the ring *A A* has its bevel side up. I am aware that it is not customary to so use it; but, as it saves making a second bed by doing so, it is worthy of consideration.

As the segment pattern to form the rim of pulley is to be drawn around endwise, it is not made as long as such segments usually are for pulleys of other shaped rims. Having rammed up segment *D* full on outside, it being held in place by a number of braces, as shown at Fig. 2, they are now removed, and the inside rammed up high enough to form the bed at *B*, which is made by the use of strike *B*. The rim pattern is then drawn around, as before stated, endwise, and the same operation is repeated until the entire circle is completed.

In ramming up the last segment, the inside is omitted, so as to admit of the rim pattern being withdrawn from the sand. After checking outside off, the segment can be replaced and the inside finished to joint *B*. It may be here stated that in ramming up inside to joint *B*, the bed of sand swept by sweep *C* would not be over six inches in width; the remainder of the bed being made after checking off by a sweep attached to the spindle. The arm cores are then placed in position, and the inside of the mould completed.

At numerals 1 and 2 is shown a plan of resting the weights on the arm cores. It consists in building up bricks to the required height, while the mould is in course of construction, upon which are placed two cast-iron circular flat plates; previous to putting bricks on the arm cores it is best to put on a little loose sand and rub on an iron plate or a board. This way of weighting a pulley admits of securing hub core *E* nicely, by putting two bars over it, and letting their ends project under the inside of smaller circular plate at 2, and wedging them.

Fig. 3 shows a gauge or try stick, to be used from spindle to rim when ramming up the latter. In moulding those pulleys, the bottom flange was rodded as at *F*.

Fig. 3.

Fig. 2.

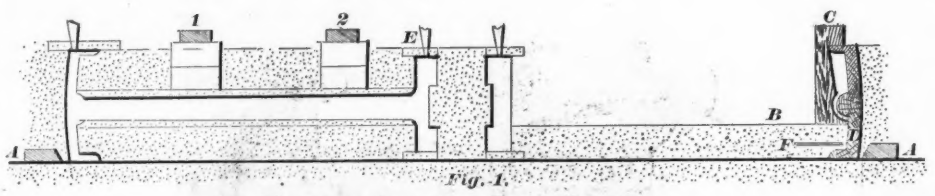


Fig. 1.

Moulding Crowning Faced Pulleys.

The firm employing this system of moulding pulleys, in making their largest sizes, had the lifting ring *A A* made in halves and checked off one-half at a time.

I am aware that this method of moulding pulleys could not be practiced on pulleys exceeding certain sizes. It is also a mode, so far as my experience goes, that is not common; but I think it superior to many others I have seen, for this particular shaped rim.

George O. Vair.

On the Steel Question.

Editor American Machinist:

I must differ a little from Mr. Viall (American Machinist, March 7,) in relation to steel. I have had practical experience in working steel of all grades, of English, German and American, since the year 1853, more particularly English and American brands. I am not American born, but I have been an American citizen twenty-four years, and have no prejudice in the matter. I learned my trade on the other side of the water, and have good reason to know that there are as many worthless brands of steel there as here, and just as many complaints about poor steel.

The steel I have had most to do with is used for taps, dies, and all kinds of machinists' and roll turners' tools, and up to 1878 or 1879 I have seen as much trouble with American steel as with English. About that time great advances were made in American steel, and from then I have American steel ordered for the kind of work it has to do, and I have no further trouble. It is with steel just as with anything else: you must pay more for a good article than for a poor one. Then, again, a good deal of the complaint about steel is due to ignorance and carelessness in working it.

Rockwood, Tenn. Geo. Jones.

Collars on Line Shafts.

Editor American Machinist:

No one is satisfied with a collar put on a line shaft with a set screw. Very few are ever put on any other way, and, when they are, no one else likes that way, either.

I have thought of a plan that I shall adopt when I get a chance. It is this: Have two good wrought-iron or steel collars turned and bored a shrink fit, and shrink one on the line at each end of the box next the main driving pulley. If I ever want to get them off I will use hammer, cold chisel and sledge, and make new ones if wanted somewhere else. The collars should be at opposite ends of the same box, and not at opposite ends of the shaft. The shafts seem to go nice when there is about ¼″ end play, and goes that quarter of an inch, too, if level and it has a chance.

I know collars have been welded to a shaft times enough, and collars shrunk on in place of welding; but the point I wish to make is to shrink on a collar in the place of putting it on with a set screw or some complicated arrangement. John E. Sweet.

Copper, cast, weighs, at an average, 544 pounds per cubic foot.

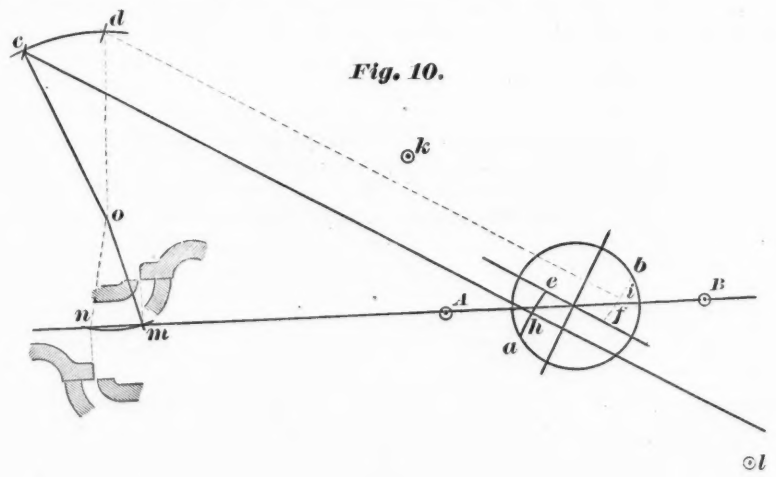


Fig. 10.

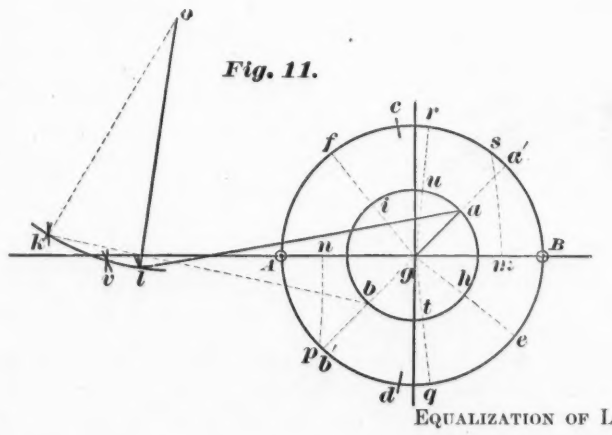


Fig. 11.

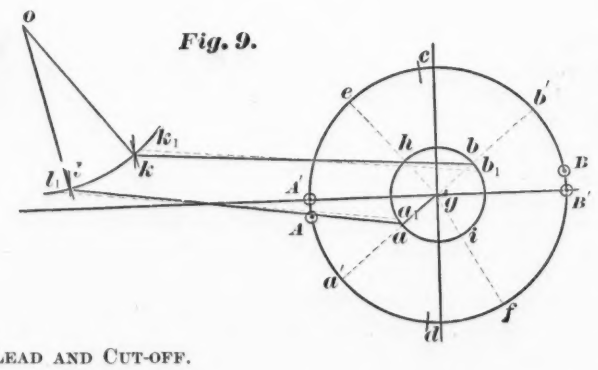


Fig. 9.

Equalization of Lead and Cut-off.

New Development in Scotch and Irish Passenger Steamship Service.

Messrs. Burns, the well-known shipping firm, intend this year to make a new departure in the passenger steamship service between the Clyde and the North of Ireland. Hitherto the voyage could not be made in less than two days, the journeys being during the night and in the summer months during the day also; but now a fast paddle steamer is to conduct an additional service, the special advantage of which would be that the double journey can be made in one day, with three hours ashore at Belfast. The vessel for this service was launched on Saturday, from the yard of the Fairfield Shipbuilding and Engineering Company on the Clyde. The steamer, which is named Cobra, is 275 ft. long over all, and 265 ft. between perpendiculars; 33 ft. beam, 22 ft. 6 in. in depth; with a gross tonnage of 1,000 tons. The engines are to be of the compound type, with cylinders 50 in. and 92 in. in diameter with a piston stroke of 5 ft. 6 in. Steam is supplied from four single ended boilers 14 ft. 6 in. in diameter by 10 ft. 3 in. long, each having three of Fox's corrugated furnaces. —*Engineering.*

The Equalization of Lead and Cut-off in Slide Valve Engines.

By Frederic A. Halsey.

THIRD PAPER.

It will be remembered that the construction of Figs. 3, 4 and 5 was made with the crank on the center, while that for Figs. 6 and 7 was made with the crank in position for admission of steam, and that in Fig. 8 these methods were reconciled by supposing the admission to occur on the center. No material error would be introduced if this method were followed in all cases; but if it is desired to follow the strictly correct method it can be done in the following manner: Fig. 9 is a reproduction of Fig. 7, constructed for the mean throw of the eccentric, with some additions. Find points b_1, a_1 and k_1, l_1 corresponding with crank positions A_1, B_1, and draw $k_1\ b_1$ and $l_1\ a_1$. Now the construction of Fig. 7 gives the positions of $k\ b$ and $l\ a$, while it is desired to make $k_1\ b_1$ and $l_1\ a_1$ parallel by suitably selecting the eccentric rod length. This should be done by trial, as before, repeating the trial until the desired result is reached.

APPENDIX.

It has been stated that, as now built, the Straight Line engine has an inconstant with equal lead. The reason for this change is as follows: In shifting eccentric engines, as is well known, the compression increases as the cut-off grows shorter. The total cushion by which the momentum of the reciprocating parts is arrested is the sum of the exhaust cushion and the lead cushion. Now if the total cushion is to be constant at all points of cut-off, as it should be, the lead must decrease as the compression increases, and at the early cut-offs the lead should be negative. Furthermore, in such engines, as is well known, both the release and compression for early cut-offs occur earlier than is desirable. Now by laying out two valves for the same cut-off, one with positive and the other with negative lead, it will be found that the valve with negative lead gives considerably later release and compression than does the one with positive lead. In other words, the introduction of negative lead at the early cut-offs, in addition to offsetting in a measure the increasing compression, also prolongs the expansion, thereby getting more work out of the steam, and also delays the compression, thereby still further reducing the cushion. The result is accomplished as shown in Fig. 10, which is a modification of Fig. 5. The point k, instead of being on the line $d\ i$, is placed above it. This brings l equally below $c\ h$, extended, and, as will be seen by referring to the upper valve sketch for m, and the lower one for n, reduces the lead for both crank positions A and B, as the eccentric is

shifted inward toward *e* and *f*. If the elevation of *k* above *d i* is sufficient, the lead at the early cut-offs will obviously be negative. To fully appreciate the merit of this construction, Fig 10 should be compared with Fig. 1, when it will be seen that while in Fig. 1 shifting the eccentric inward from *h*, *i*, decreases the lead in the upper valve sketch, it increases it in the lower one; in Fig. 10, on the other hand, shifting the eccentric inward from *h*, *i*, decreases the lead in both valve sketches.

At the close of the description of Fig. 6 it was stated that the rocker fulcrum might be located indifferently at either *o* or *o'* of that figure. This is strictly true so far as relates to equal lead and cut-off, but there is still a difference in the effect of the two positions. By suitably locating the fulcrum the compression and exhaust can be equalized for the two ends of the cylinder—exactly if the valve have no inside lap, and approximately if it have such lap. This has not the unique interest which belongs to the equalization of lead and cut-off, because it can be accomplished by other means, but it forms an interesting study, nevertheless. The method of accomplishing this equalization is shown in Fig. 11, which follows the construction of Fig. 6 up to and including the finding of *k*, *l*, but with lead zero. Suppose, in the first instance, that the valve has no inside lap, and by any of the well-known methods find the points of the piston stroke *m*, *n*, where release and compression should occur, and by arcs whose common radius is equal to the length of the connecting rod find the corresponding crank positions *s*, *p*. Lay off *A c s* from *a'* giving *q*, *B d p* from *b'* giving *r*. Draw *q g* and *r g* giving *t* and *u*, where the eccentric must be for the two equalized compressions. With radius equal to the eccentric rod, and centers *t*, *u*, strike arcs meeting in *v*. Now locate the rock shaft fulcrum at *o*, such that the eccentric rod pin shall pass through *k*, *l*, and *v*, and the result will be a valve motion giving equal lead, cut-off, release and compression. If the valve have inside lap, then, instead of one point, *v*, there will be two, just as with outside lap there are two points, *k*, *l*. In that case it will be found impossible to so locate *o* that the eccentric rod pin shall pass exactly through all four points. It should be then made to pass through *k* and *l*, and the difference be divided between the two points *v*. The release and compression will then be as nearly equalized as is possible.

Some of your readers may object that these articles give undue prominence to the Straight Line engine. However, those who know Professor Sweet, and his constant practice of giving to others every morsel of credit which is their due, will not, I am sure, complain.

The Milling Machine and its Operations.

By A. B. Landis.

No. 4.

The dividing head of the Universal Milling Machine, as made by Brown & Sharpe and others, is adapted for a greater range of dividing than, I think, it has been credited with, since I never saw its full adaptation given in print. The idea pretty generally is that the dividing head is for circular dividing only, and perhaps it was never intended for any other; but by a slight change it is adapted to straight line dividing, and it will do it with a degree of accuracy not attainable with a graduated circle on the traversing screw. I had racks to cut, and drilling of templates, wherein a large number of holes were required, which had to be equally spaced, and I got such good results that I cannot but mention the matter, that those not having thought of the plan, who may find value in it for themselves, may avail themselves of it.

The necessary changes or additions, as you may term them, are: Take any of the index plates which belong to the machine, and drill a circle of fifty holes within the inner circle. Apply a drag-link-pin on the stop-pin, which holds the index plate stationary for circular dividing. What I mean by drag-link is a piece of steel extending downward from this stop-pin and fastened to it, with a pin on its end to engage with the holes of the fifty-hole circle, which is adapted to do this by swinging to meet the circle.

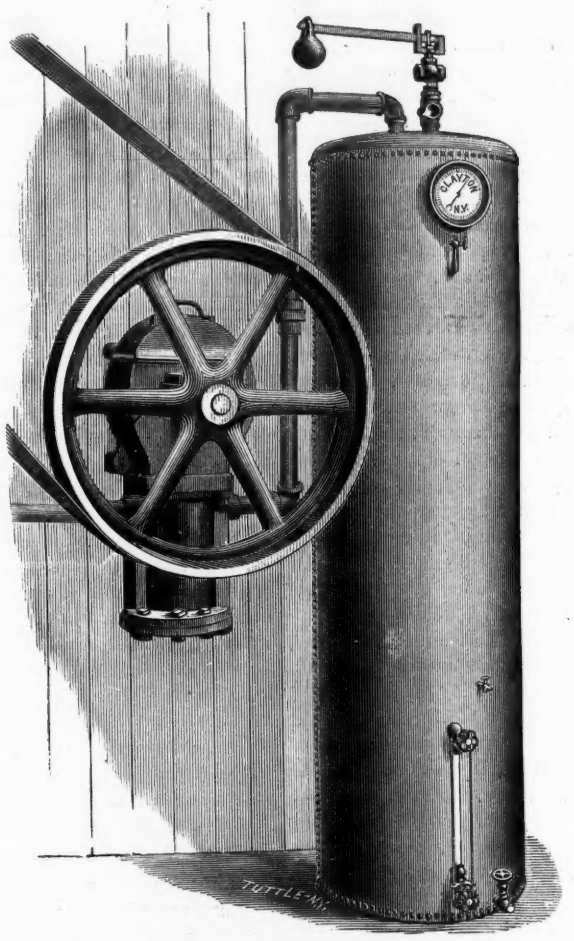
A (perhaps) more preferable plan would be to make a separate plate, and drill a circle of fifty or one hundred holes of a diameter to coincide exactly with the stop-pin, and thus do away with the link spoken of.

The idea of fifty or one hundred holes is that straight line dividing can be done by the movement of the platen, and measurements made by one one-thousandth inch or the half of one one-thousandth. Now by gearing the dividing head with the screw five to one, and the screw having four threads to the inch, we have in the case of the fifty circle, one-thousandth inch for each hole, and one-half-thousandth inch for each hole in the case of the one hundred hole circle.

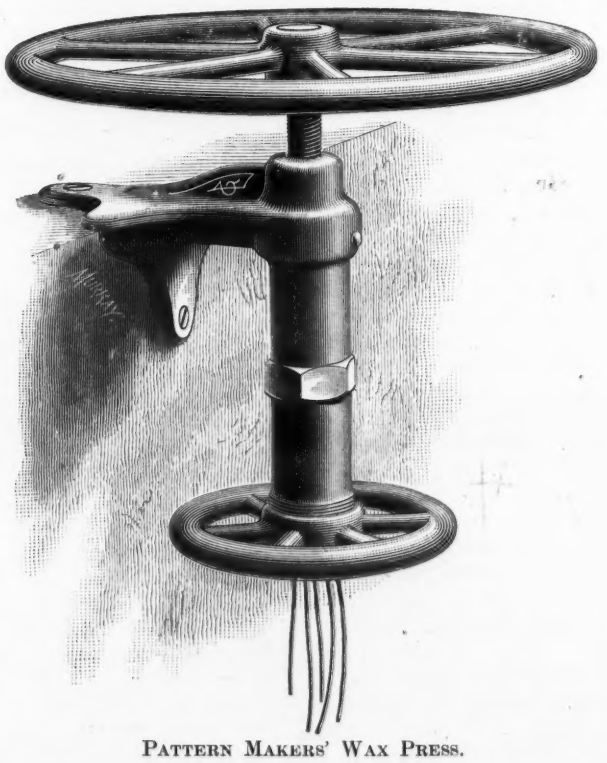
To gear five to one, use gear 100 on the screw, 32 and 64 on the stud, and 40 on the head. The above figures are for the Brown & Sharpe Universal Milling Machine. They may or may not be applicable to others, but the plan is applicable, by figuring what is necessary.

For rack cutting, this makes a very desirable arrangement (as well as for all dividing), as there is no liability to mistakes, since the "sector" on the index can be used as well as in circular dividing, whereas, with the graduated circle on the screw (used by some) there is liability to mistakes, and it necessitates counting the graduations.

In cutting a rack of say six pitch, by reference to the table of comparative diametral and circular pitches, we find the circular pitch to be .5236 inch; consequently it is necessary to turn the index circle 10 revolutions and 23 holes with a fifty hole circle, or 47 holes with one hundred holes, which is practically near enough. The advantages will be clearly seen, and if the screw is correct, as it should be, the work cannot but be so.



Vertical Belt or Hand Air Compressor.



Pattern Makers' Wax Press.

The city authorities in Paris reserve the right of purchase of the electric lighting plants for city lighting any period after the first ten years of the concession of privileges.

The Clayton Vertical Belt or Hand Air Compressor.

There has long been a demand for a cheap yet serviceable belt power or hand-actuated air compressor, to furnish air under any pressure up to 300 pounds per square inch for experimental and other purposes, and we now present to our readers an illustration of such a compressor, showing it as in actual operation, bolted against a wall or strong board—it requires no foundation—with pipe connection to air receiver, which is provided with pressure and glass water gauges and safety valve.

The pulley wheel is of such weight, diameter and width of face, as is advisable to attain the pressure wanted; when required to be worked by hand power, they are provided with a handle in the fly wheel, and the compressor can be run by one or two men to a proportionate pressure.

These compressors are built very strong, with heavy crank-box and bearings, steel crank and composition valve-box and valves.

Large numbers of them have already been sold for atomizing crude petroleum for fuel, supplying air under high pressure to automatic sprinklers, supplying an air blast in glass works, testing tin cans, lead burning, and many experimental operations to determine the feasibility of employing compressed air for various purposes.

We have previously illustrated the large steam-actuated air compressors made by this firm for use in mining and kindred purposes, and we have no doubt this machine will meet with equal favor and find a place in many establishments where a limited amount of compressed air is used up to 300 pounds pressure. It is made by the Clayton Air Compressor Works, No. 43 Dey street, New York city.

Pattern Makers' Wax Press.

The cut shows a wax press for pattern makers, made by F. B. Finch, Troy, N. Y. It presses wax into strips or strings of any desired shape or size, round, triangular or other, for filling in the corners of patterns. The press can be attached to the corner of a bench wherever most convenient. The barrel is filled by screwing the piston up to the top and inserting a solid cylinder of wax at the bottom. Then the cup is screwed on by means of the small hand wheel, with any sized mould required, and the wax can be immediately pressed out. The cylinders of wax should slip loosely into the barrel, and can be cast by any one in a wooden mould, or can be supplied by the maker of the press in any quantity. Many more strings are run out at a time than are here shown. They have been cut away, to avoid confusion.

The use of the press must effect a great saving of time, produce neater patterns, and generally promote correct practice in pattern making, by making the use of round corners wherever possible an easy matter.

The great nations of the earth are spending, and preparing to spend, immense sums of money in reconstructing old and building new navies, and it is not certain that either of them will have a navy of much consequence when they are through. New war ships, just like new machines with novel features, must be tried before much is known about them. Building navies is not only costly, but mighty uncertain.

The Charleston *Courier and News* gives some figures going to show that South Carolina is progressing remarkably in establishing manufacture. According to these, the capital employed in manufacture in the State is three times as great as in 1866. In 1880, manufacture is credited with 23 per cent. of the industrial product of the State, while in 1887 it was 31½ per cent.

At the close of the year 1887 there were 1,878 miles of railway in operation in Switzerland. The returns upon the capital invested was 3.45 per cent.

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Metric System of Measurement.

The action of the New England Railway Club at its Boston meeting, not long ago, in recommending to the railroad master mechanics of the country the general adoption of the metric system of measurement, has again aroused some discussion of the subject, and considerable surprise is expressed at such action being taken by a society having among its membership such a large proportion of practical men, who have had actual experience in the construction and maintenance of railroad equipment. Propositions to make the metric system the standard of measurement in this country have heretofore come almost exclusively from those who have known little or nothing of practical shop work, and who have, consequently, seemed to imagine that in making the change from our present system to the metric, nothing more would be required than to simply provide ourselves with scales or rules, graduated by the metric system, throw away the old ones, and, presto! the change is made. They examine the metric system simply, without reference to anything else; its simplicity charms them, as it must charm any one who takes the trouble to examine it, and, without stopping to inquire what a change from one system to the other would involve, they advocate the change.

We think, however, that no one can successfully maintain that some decimal system of weights and measures, if once fully adopted to the exclusion of all others, would not be an improvement upon our present systems. We are inclined to think that those who argue against the superiority of the metric system over our present one, place themselves at a disadvantage, and will inevitably get the worst of the argument. While it is doubtful if the metric system is the best possible decimal system, we think there can be no reasonable doubt that a decimal system of some kind is superior, in point of convenience, to any other in use. That this is the fact we think is proven by the universal practice among men having much to do with figures to work with decimal fractions rather than with common fractions, the reason being that they are much the most simple, and more easily used in making computations.

Few Americans could be found who would argue the superiority of the English or French systems of money over our American system. Every one knows that ours is far more convenient and superior in every way, and it is so simply because it is nothing more or less than a decimal system of measuring values. Except in cities, or where it is divided into small lots for building purposes, land is always measured by surveyors by a decimal system of measurement, *i. e.*, by chains and links, one hundred links making a chain, and ten square chains an acre. Quantities of land are always expressed by surveyors in acres and decimal parts of an acre, and the necessary computations are rendered very simple and easy because it is a decimal system. One of the best tests of the value of a decimal system, compared with others, in respect to convenience, is found by computing the value of a piece of land containing say six and seven-hundredths acres at $100 per acre. Expressed decimally in figures this would be 6.07 x $100, and instantly, by mere inspection, we know the value to be $607. Now compute the value of the same land at 25 pounds sterling per acre, and express the result in pounds, shillings and pence, and note the difference in the amount of work required. Then express the amount of land in acres, roods, rods and yards, and again compute its value in English money. Any one trying this will, we think, never again be disposed to deny the superiority of decimal systems of measuring either magnitudes or values.

Specific gravities are always expressed decimally, and every one knows that it would be far less convenient to have them expressed in any other way. The tables giving the weight of bar iron always give it in decimals of a pound per foot, and, by using a rule divided into hundredths of a foot, the length of any sample piece—many duplicates of which are to be made—can thus be readily determined in decimal parts of a foot, and the weight of iron required for the given number determined with almost infinitely greater ease than it could be done if the measurement were made in inches and binary divisions of the inch, and the weights given in pounds, ounces, and fractions of an ounce.

Many such examples could be given, going to show that, whatever may be said regarding the natural development of the binary divisions of units of measurement, the decimal system is far the most convenient, and is for that reason made use of by practical men as well as others, wherever it is possible to do so.

The confusion and multiplicity of figures dwelt upon by some of our contemporaries, as an objection to the metric system, is, by their own showing, not due to the complexity or cumbersomeness of the metric system *per se*, but to the mixture of that system with our present system, which is not what the advocates of the former system have in contemplation. They look to the abandonment of our present system entirely, and the substitution of the metric system, and the only fault that can be found with them is that they utterly fail to appreciate the magnitude of the undertaking. The fact that practical men do adopt and use decimal systems of measurement and computation, whenever possible, proves that their opposition to the French decimal system is not the result of ignorance or blind prejudice, as many declare it to be, but is due solely to the fact that they are able to form a clearer conception of the immeasureable expense and inconvenience which would have to be borne by those who made the change.

If this present generation could absolutely throw away every instrument for measuring and indicating dimensions by feet and inches, as well as all tools, fixtures and gauges used for maintaining our present standard sizes, adopting the metric or some other decimal system in its stead, future generations might be benefited. But it is impossible for us to do that, and, even if possible, it would be a sacrifice which we are not called upon to make. It is this practical impossibility of making the change which the advocates of the metric syetem either overlook or are utterly incapable of appreciating, and it is this which will, we think, absolutely prevent its general adoption. The universal law, that "man seeks to supply his wants with the least possible exertion," will operate in this as in other matters. That law has led to the adoption of decimal systems in the instances we have mentioned, and it will inevitably force the adoption of such a system wherever the lines of least resistance lie in that direction.

A Cause for Rejoicing.

Although predictions about such things are often uncertain, it seems reasonably safe to assume that the great copper syndicate has gone to pieces, financially, through the greed engendered by the gigantic proportions of its contemplated unholy operations. It is a case of "vaulting ambition" jumping too high. With what becomes of the pieces the public has little concern. A few of the leading spirits will probably contrive to gather up most of them. But the public has good cause to rejoice that the greater part of those who put their money into a scheme to rob others will come out of the operation poorer than they went into it; to rejoice in the fact that the copper syndicate is "hoist with its own petard"; that it has gone to pieces through its own greed.

Those who are curious in such matters have undoubtedly wondered what the end would be in the matter of cities and towns paying manufacturers for locating within their limits. The figures in the way of inducement are already getting high, and the tendency is upward. Perhaps the limit will be when the "inducement" is sufficient to set a manufacturer up in business, although it may go on till a comfortable bank account is included.

Some years ago there was a craze in the direction of towns bonding themselves for the purpose of assisting in building railroads. And the effort to get rid of paying these bonds was sometimes quite as strong, if less noisy, than the effort to assume the obligation. There may not be much in common between paying for other people's railroads and putting up manufactories for other people. We hope not, for if there is it will in some instances be found that too great inducements have been offered the manufacturer.

There is a good deal of nonsense indulged in by the daily press, because a man who is capable of making or mending a shoe, when occasion requires, has been elected mayor of a small western city. It is not urged that the shoemaker mayor did not make good shoes, or do an honest job in the way of putting dilapidated shoes to rights, but—oh! the shame of it—he has earned an honest living with leather, and waxed ends, and awls! Honesty and ability will never count with some folks against that. The shoemaker ought to stick to his last, and, by parity of reasoning, Lincoln ought to have kept himself at splitting rails, and Garfield at urging refractory hybrids along the tow-path. But a line must be drawn somewhere, and it appears in the reasoning of some great minds that it should be at cobbling.

Literary Notes.

STEAM BOILERS: Their Management and Working on Land and Sea. By James Peattie. E. & F. N. Spon, 12 Cortlandt street, New York.

The author of this book is a practical engineer, and has had thirty years' experience about boilers; hence, as might be expected, he has written for practical men rather than for those of scientific attainments. His views as to who should and should not be put in charge of steam boilers are tersely stated as follows:

The practice of putting in charge of steam boilers, boys and other persons who are as ignorant of the duties as of the risk incurred, is just as reprehensible as placing in charge of a spirited horse a person who never saw one before. . . . The man to select for a boiler attendant or engineman must be a sensible, steady, methodical and inquisitive man, who can weigh the philosophy of common things as he goes along.

The subjects taken up in turn are those that are of interest to engineers and firemen, comprising the nature of the materials and substances with which the boiler attendant should be familiar, as well as the various duties he has to perform.

The book is written in a plain, straightforward style, a style that is pleasing, and at times amusing. While the text is addressed more to those handling marine boilers than to those having stationary boilers in charge, there is so much that is common to both, that little fault is likely to be found in this respect. Terms more common to English than to American practice are sometimes made use of, but they are such as will at once be understood. It is in every sense of the word a book for practical men, and we have no doubt any engineer or fireman will be benefited by reading it. The price is $2.00.

Questions and Answers.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

In our answer to Question 124 (issue of March 14), we inadvertently gave as foot pounds what were really inch pounds. The mistake is so obvious that few will be misled by it. Instead of there being 1256.6 foot pounds, as stated, it would be one-twelfth of that amount, or 104.7 foot pounds.

(140) J. P., Newark, N. J., cannot ascertain the exact horse-power of an engine without the use of an indicator or a friction brake.

(141) J. B., Brooklyn, N. Y., asks: Which causes the most work on a pump, to elevate water with a connection made at the bottom of a tank or

over the top, both pipes of the same area? *A.*—Over the top, because you must raise the water to a greater height.

(142) F. S., Orono, Me., writes: Please give me a general method for determining the necessary amount of condensing surface for amarine engine. You may assume your own data. *A.*– See answer to Question 493, in our issue of Nov. 10, 1888.

(143) L. P., New York, writes: I would like to become an engineer. Would you please inform me which books treating on the locomotive, and those which give illustrations of the different parts of the same engine, I should study? *A.*—See answer to Question 9, in our issue of January 7, 1888.

(144) C. G. C., Orono, Me., asks: How much faster, if any, will a log floating in a stream run than the surrounding current of water? The course to be straight, and no rapids. I claim that the water runs the fastest, but some of my friends contradict me. *A.*—You are right; the surrounding water will run faster than the log.

(145) E. C. B., Kansas City, Kan., writes: Please give rule for finding the pressure it takes to lift simply the lever and valve of an ordinary safety valve. *A.*—First find on the lever the position of its center of gravity; this you may do by balancing the lever on a knife's edge; the vertical line drawn on the lever from the knife's edge will pass through the center of gravity. Measure the distance from this line on the lever to the center of the fulcrum; multiply this distance in inches by the weight in pounds of the lever, and divide the product by the distance in inches from the center of the valve to the center of the fulcrum; the quotient will be the total pressure on the valve required to lift the lever only. Add to this pressure the weight of the valve and stem; the sum will be the total pressure required to lift the valve and lever. To find the pressure per square inch on the valve, divide the pressure just found by the area in square inches of the valve; the quotient will be the pressure per square inch.

(146) A. R., East Albany, N. Y., asks: 1. Can you tell me what questions an applicant for a license to act as a steamboat engineer may have to answer? *A.*—There are no set questions asked; you must be a thorough master of your business, and be able to answer any questions relating to it. The qualifications which the applicant must possess are given in our answer to Question 320, in our issue of July 7, 1888. 2. I know the rule for finding the weight on a safety valve lever, but I do not understand it. Please explain why you multiply the pressure on the valve by the distance of the valve from the fulcrum; and also why multiply the weight of the lever by half of its length. *A.*—The pressure on the valve has a tendency to turn the lever around its fulcrum; the weight has a tendency to turn the lever around the same fulcrum in an opposite direction. The measure of the effect to produce rotation, or the tendency to produce rotation, is the moment of the force. The moment of a force, in reference to a point (which in this case is the center of the fulcrum pin), is the product of the force into the perpendicular distance of the action line of the force from the point. The steam pressure on the valve is the force which tends to turn the lever around its fulcrum; the center line of the valve and spindle represents the action line of this force, and for the sake of brevity we may say the action line is a vertical line, as it really is in many cases. If we now assume that the lever occupies a horizontal position, as is often the case, then the distance from the center line of valve to the fulcrum is the perpendicular distance from the action line to the point about which the lever tends to rotate. Hence, according to the definition, the effect of the total steam pressure on the valve to produce rotation is measured by the product of the total steam pressure on the valve into the distance from the center line of valve to the fulcrum. The weight is the measure of the force of gravity, and its action line is a vertical one passing through the center of the weight; the perpendicular from the point (that is, the fulcrum,) about which the lever tends to turn, to the action line of the weight, is the distance or length of the lever from the center of weight to the center of fulcrum, and its tendency to produce rotation is again measured by its moment, that is, the product of the weight into the length of the lever. Any elementary work on mechanics will give you a clear conception of this subject, and we should advise you to procure one and study it. The weight of the lever has also a tendency to produce rotation; the action line of the weight of the lever passes through its center of gravity, and when the lever is of uniform thickness and breadth throughout, the center of gravity will be in the center of its length, and its tendency to produce rotation is again measured by its moment, that is, by the product of the weight of the lever into the distance from the center of gravity to the fulcrum.

(147) B. T., Denver, Col., writes: Which of the two following steam motors will pull the most dead weight on a level straight track, without sand? Motor No. 1 has two cylinders, 9x12 inches; four drivers, 33 inches diameter; total weight on drivers, 10 tons. Motor No. 2 has two cylinders, 7x12 inches; four drivers, 24 inches diameter. In both engines ordinary slide valves are used, of equally good design. Steam pressure on piston, 130 pounds per square inch. *A.*—The tractive force of these motors can be computed by the following rule: Multiply the square of the diameter in inches of one piston by the mean effective pressure per square inch, and also by the length in feet of stroke; divide this product by the diameter in feet of one wheel; the quotient will be the tractive force in pounds. Assuming that steam is cut off at ¾ stroke, the mean effective pressure on the piston, will be, say, 118 pounds. Hence, according to the given rule, the tractive force of motor No. 1 will be

$$\frac{9^2 \times 118 \times 1}{2.75} = 3{,}475 \text{ pounds (fraction is omitted).}$$

And the tractive force of motor No. 2 will be

$$\frac{7^2 \times 118 \times 1}{2} = 2{,}891 \text{ pounds.}$$

Whether the motor can really emply this tractive force or not will depend on the weight on the drivers; this weight must be such as to give the proper amount of adhesion between the rails and wheels. The adhesion in pounds should never be less than the tractive force; in fact, it should always be a little more, so as to prevent the wheels from slipping. For good dry tracks the weight on the drivers should be equal to five times the adhesion. Hence, making the adhesion equal to the tractive force, we have for the weight on the drivers in the first motor $3{,}475 \times 5 = 17{,}375$ pounds, or, at 2,000 pounds per ton, we have $\frac{17{,}375}{2{,}000} = 8.68+$ tons, which shows that the given weight on drivers in the first motor is sufficient. The weight on drivers in the second motor should be

$$\frac{2{,}891 \times 5}{2{,}000} = 7.22 \text{ tons,}$$

which shows that the given weight on the drivers in the second motor is not sufficient for the size of cylinders or steam pressure.

Lastly. Assuming that every 7½ pounds of the tractive force will haul one ton, we find that the first motor can haul

$$\frac{3{,}475}{7.5} = 463 \text{ tons.}$$

The second motor, with the proper weight on drivers, can haul

$$\frac{2{,}891}{7.5} = 385 \text{ tons (fraction omitted).}$$

With six tons, at 2,000 pounds per ton on the drivers, the second motor will only haul 320 tons. Whether or not the required speed can be obtained with these motors will depend on the steam generating capability of the boilers.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Thursday for the ensuing week's issue

Gear wheels and g-cutting. Grant, see adv., p. 16.
Link-Belting and Sprocket Wheels.
Send for Catalogue of Link-Belting.
Over 50,000,000 feet of Link-Belt in use.
Link-Belt Engineering Co., Philadelphia and N. Y.
Shafting Straighteners. J. H. Wells, Tampa, Fla.
Steel Name Stamps, etc. J. B. Roney, Lynn, Mass.
Duplex Gear Cutters. R. M. Clough, Meriden, Ct.
Structural Ironwork. A. E. Jenkins, Scranton, Pa.
Upright Drills. J. E. Snyder, Worcester, Mass.
Upright Drills. J. E. Snyder, Worcester, Mass.
Upright Drills. J. E. Snyder, Worcester, Mass.
Upright Drills. J. E. Snyder, Worcester, Mass.
The best Upright Hammers run by belt are made by Jenkins & Lingle, Bellefonte, Pa.
Berryman Feed-Water Heater and Purifier. Benj. F. Kelley, 91 Liberty street, New York.
Drop presses, punches and shears. Williams, White & Co., Moline, Ill., manufacturers.
R. Dudgeon, 24 Columbia st., New York, Improved Hydraulic Jacks and Roller Tube Expanders.
Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.
"Swift" Sight Feed Lubricator; no glass tubes; simple, reliable. Swift Lub'r Co., Elmira, N. Y.
Power measured with guaranteed Dynamometers. Franklin Van Winkle, 91 Liberty st., New York.
Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.
"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.
Round Adjustable, Round Solid, and Square Dies, all sizes. Mfd. by S. W. Card & Co., Mansfield, Mass.
Fire Brick and Clay Retorts; large variety; special shapes to order. Borgner & O'Brien, Philadelphia.
Selden Packing, for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y.
Brown & Sharpe Mfg. Co. have a line of machinery with S. A. Smith, 23 S. Canal st., Chicago, Ill.
Ice and Refrigerating Machines, 131 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.
For the latest improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.
Engine lathes, hand lathes, fine tools, files and supplies for machinists and other metal workers. Frasse & Co., 92 Park Row, N. Y.
Most sensitive and durable Damper Regulator made; works within one pound; send for circular. T. Kieley, 11 W. 13th st., New York.
Buy the best Upright Drill; finely made, great capacity and quickly operated. 20″, 21″, 23″, 25″, 28″, 32″, 36″ swing. J. E. Snyder, Worcester, Mass.
Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See March 7, p. 14. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.
"Curiosities of the U. S. Patent Office." A great book. Goes like hot cakes. 12 pp. pamphlet for stamp. *Get one.* W. C. Raymond, Syracuse, N. Y.
Fine tools and supplies for machinists and other metalworkers. Get our prices before purchasing elsewhere. Montgomery & Co., 105 Fulton st., N. Y. City.
With my Vacuum System, Exhaust Steam Heating costs nothing for fuel; Live Steam Apparatus altered to Exhaust. Satisfaction guaranteed. Geo. A. Barnard, 15 Cortlandt street, New York.
W. H. Hoffman, consulting engineer, 108 Liberty st., room 3, N. Y. Mechanical engineering in all its branches, working drawings for the transmission of power by steam, water, air and electricity.
Contract work of all kinds executed promptly and on reasonable terms. Parties wishing grey iron castings in large quantities can make money by corresponding with Rawson Mfg. Co., Hornellsville, N.Y.
The Vance Lightning Flue Cutter is *the* tool for removing old flues from boilers and locomotives (will cut fifty an hour); sent on approval to railroad companies. Vance Tube Cutter Co., Geneva., N. Y.
Standard Drawings of Improved Corliss Engines: Non-Condensing, Condensing, Compound and Triple Expansion. New Valve Gear and Dash Pot; also all branches Mechanical Engineering. Conover & Co., 219 Market st., Newark, N. J.
Steam Boilers: Their management and working on land and sea. By Jas. Peattie. Practical facts from 30 years' experience. 230 pages, illustrated, 12mo., cloth, $2.00. Circulars and Catalogue of Books for engineers free. E. & F. N. Spon, 12 Cortlandt st., N. Y.
Patterson, Jordan & Gottfried, 146-150 Centre st., N. Y. Metals, Machinery, Hardware, Tools and Supplies for Machinists, Mills, Engineers, Brass Goods Mfrs., Factories, etc. An extensive assortment of Bolts, Screws, Wire, Taps, Drills, etc., carried in stock.
For Reflecting or Refracting Telescopes, Spectroscopes, Object Glasses, Specula, Polarizing Eye Pieces, Heliostats or any apparatus for Astronomical Photography or Observation, address J. A. Brashear, Allegheny, Pa. We furnish Specula or Objectives, or any accessories with drawings, so that mechanics and amateur astronomers can mount their own telescopes.
"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 15 Astor place, New York.
"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G Co., 96 Fulton St., New York.
"Practical Drawing." By J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, should be closely followed by every student. They commenced with October 23, 1886 issue, and up to and including March 14, 1889 issue, 72 articles have been so far published. Copies containing these articles sent by mail to any part of this country or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING Co., 96 Fulton st., New York.
"Modern Locomotive Construction." By J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, are attracting the attention of railway mechanics all over the world. Commencing with the June 27, 1885 issue, 87 articles have thus far appeared up to and including the March 21, 1889 issue. Copies containing these articles sent by mail to any part of the U. S. or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING Co., 96 Fulton st., New York.

MANUFACTURES

J. M. Brown will build a lumber mill at Montezuma, Ga.

The Chattanooga (Tenn.) Machinery Works are increasing facilities.

J. B. Hiller is increasing the size of his planing mill at Pittsburgh, Pa.

B. H. Ryder is building a machine shop and foundry at Troy, Ala.

The Scottdale (Pa.) Iron and Steel Company will enlarge its plant this spring.

The Georgia Southern & Florida have begun work on their shops at Macon, Ga.

A boiler shop is being built by Casey Brothers at Chattanooga, Tenn., to employ 80 men.

The Moffatt Manufacturing Company will build a machine shop and foundry at Chester, S. C.

The machine shops in Louisville, Ky., are said to be busy, with every prospect of a busy year.

The Lauderdale Manufacturing Company are building a large cotton mill at Florence, Ala.

The Boston & Albany Railroad Company is building a wood-working shop at Providence, R. I.

The Deoxidized Metal Co., of Bridgeport, Conn., are about to erect an additional building in that city.

The Fuel Gas & Electrical Engineering Co. expect to build a machine shop and foundry at Wilmerding, Pa.

The Woodburn Wheel Company is building new works at Indianapolis, Ind., to cover three acres of ground.

A flour mill will be built at Liberty Hill, Texas, by a company known as The Liberty Hill Roller Mill Company.

The Lauderdale Manufacturing Co. proposes to build a large machine shop at Florence, Ala.; also a buggy factory.

The citizens of Galveston, Texas, are confident of raising the $50,000 required to secure the location of the Santa Fe railroad shops.

D. J. C. Arnold, New London, Ohio, has issued an 1889 catalogue of brick and tile makers' machinery. He furnishes everything in this line.

The Standard Railway Signal Co. has been organized at Columbus, O., with J. B. McDonald as president, to manufacture the electric signal of A. Z. Boda.

The Chattanooga (Tenn.) Tool Works are increasing the capacity of their works by 300 per cent., the addition having been rendered necessary by rapidly increasing orders.

The Kansas City, Springfield & Memphis Railway Co. is building shops at Springfield, Mo. The main shop is 113x317 feet; in addition to this there will be a blacksmith shop and boiler shop.

The Chattanooga (Tenn.) Foundry and Pipe Works are building an addition to their works at a cost of $10,000, and will increase the capacity of the works one-third, and add fifty workmen to the working force.

The Commercial Lock Company, to manufacture locks, has been organized at Portland, Me., with capital stock of $25,000; par value shares, $10. President, Wm. J. Henry, Portland; Treasurer, Herbert G. Briggs, Portland.

A company known as the Framingham Gas, Fuel and Power Company has been organized at Framingham, Mass., with a capital of $75,000. The gas will be furnished for cooking, heating, and mechanical purposes, it is said, at less than 50 cents per thousand feet.

The Hoyt Frog and Crossing Company have decided to locate at Joliet, Ill., and will commence building operations next month. They are to commence with about 300 hands, and propose to employ about 600 when in full operation, which they say will be within a year from now.

The Chicago Exhaust and Blowpipe Company is incorporated at Chicago, capital stock $200,000, for the manufacture of dust separators, furnace feeders, iron pipe, exhaust fans and blowers, and all kinds of sheet-iron work; incorporators, W. E. Allington, W. H. Curtis and H. S. Towle.

The Laidlaw & Dunn Co., Cincinnati, Ohio, are furnishing the steam pumps for the new packing house of Francis Whitaker & Son, of East St. Louis. The pumps are all the duplex pattern. The first named firm are to furnish two Galloway boilers to the Friend Paper Co., of West Carrollton, Ohio.

There is water-works agitation at Hopkinsville, Ky.; Horton, Kan.; Portland, Ore.; Milford, N. H.; Fredonia, Kan.; Enterprise, Kan.; Weirs, N. H.; Arlington Heights, Mass.; St. Johns, Mich.; Girard, Kan.; Junction City, Kan.; Marysville, Kan.; Horseheads, N. Y.; Seymour, Ind.; Charlotte, N. J.; Manchester, Conn.

The Woonsocket (R. I.) Rubber Co. has agreed to remain in Woonsocket and build a new mill if the city will fix a rate of taxation for the next fifteen years. The company also ask that they be taxed on a valuation of $200,000 on the old and new plant. At a recent meeting of the citizens of Woonsocket, it was voted to comply with the company's conditions.

The Reliance Gauge Company, Cleveland, Ohio, exhibited a large number of their safety water columns at the annual meeting and exhibition of the National Light Association, held at Chicago. Their exhibit included those of finished brass, nickeled and japanned, in a variety of sizes, including both low and combined high and low water alarms, solderless floats and other appliances.

The Edison Illuminating Company of Brooklyn, through their manager, Mr. Field, have just awarded one of the largest steam engine contracts ever placed in New York, for twelve Ball automatic compound engines of 250 horse-power each, to Charles R. Vincent & Co., of No. 15 Cortlandt street, New York. These engines will be placed in the new central Edison station in Brooklyn. It is Mr. Field's intention to make this plant a model one.

A press dispatch says: The Woonsocket [R. I.] Rubber Co. has purchased the entire Buffums Island estate of twenty acres in this city, on which to erect the largest rubber boot and shoe factory in the world, concentrating the present Woonsocket and Millville plants. This settles the long continued contest for furnishing the site on which the city of Woonsocket and the village of Millville, in Blackstone, Mass., have been rivals. The city of Woonsocket guarantees partial exemption from taxation for fifteen years.

Lodge, Davis & Co., Cincinnati, Ohio, have issued several new posters of machine tools—lathes, planers, shapers, drill presses, etc. The posters are very finely illustrated, and contain brief description of tools. This firm have their Chicago store fully equipped for business. The number of workmen at the factory has been largely increased. Two shipments of tools have recently been made to Stockholm, Sweden. They will soon bring out a new planer, possessing some novel features; also an improved milling machine.

Detrick & Harvey, Baltimore, Md., have completed five lathes for the Government, to be used in the navy yard at Washington. They are for boring and turning, and a special feature of their construction is the application of power by the use of a worm and wheel. The lathes are 54-inch swing over ways, and 36 over the carriage, which carries two tool posts. The tail stock is specially designed to receive a boring bar. These lathes are extremely strong and heavy, part of the work for which they are used being the boring and turning of the rings of built-up guns.

The Babcock & Wilcox Co., 30 Cortlandt st., New York, have issued the twentieth edition of their well-known book, *Steam*, over 75,000 copies of which have previously been printed. New plates have been made, the text has been carefully revised, and much new matter has been added. In its present form *Steam* is a handsomely bound volume of 120 large octavo pages, and is in every way suitable for the library. While it is, of course, issued for the purpose of discussing the merits of the Babcock & Wilcox boiler, *Steam* contains a good deal of information of a general character that is of value to engineers and others.

Machinists' Supplies and Iron.

New York, March 23, 1889.

Iron—American Pig.—We quote No. 1 X Foundry, $17 to $18; Lehigh and North River brands, $17.50 to $18; No. 2 X Foundry, $16 to $17: Grey Forge, $15 to $15.50.

Scotch Pig.—Coltness, $21 to $21.50; Gartsherrie, $20; Summerlee, $20.50; Eglinton, $19 to $19.25; Dalmellington, $19.75 to $20; Clyde, $20.50; Langloan, $20.50.

Copper.—We quote Lake, 16.15 for March, 15.50 for April, and 14.80 for May.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Wanted—See bottom of third column, page 11.

A 1 draftsman. Who wants him? Address A., care American Machinist.

Draftsman wants situation. Address 919 Tatnall street, Wilmington, Delaware.

Wanted—Bicycle Machinists and Assemblers. Must be first-class. The Smith Nat'l Cycle Mfg. Co., Washington, D. C.

Wanted—A competent draftsman familiar with machine work. Address, with reference, Post Office Box 1582, Philadelphia, Pa.

Sober, industrious young man, vise machinist, wants steady position in machine shop. Address Young Man, 634 West Fourth st., Wilmington, Del.

Wanted—A good live pattern maker, who also understands millwright work and is free from Societies. Address D. G., care American Machinist.

Capable young man, 23, five years' experience in drafting room and shop, wants to go to Paris with exhibit; best of references. T. O. D., Am. Machinist.

Position as ass't supt. or draftsman wanted by young mech. eng.; good practical exp.; reference, present employers. I. H. P., American Machinist.

Wanted—A foreman to take charge of our automatic screw machine department, using forty or fifty screw machines. Address Ottumwa Iron Works, Ottumwa, Iowa.

Wanted—Machinist with experience at setting up cylinder printing presses. Address, stating age, previous employment, and references, Golding & Co., 183 Fort Hill sq., Boston.

Wanted—A first class moulder, competent to superintend a foundry. Must have $5,000; a good salary will be paid to a first-class man. Address Box 78, American Machinist.

A corporation manufacturing specialties desires a foreman; must be a thorough machinist, and must have a small amount of capital. Address Manufacturers, Box 316, Buffalo, N. Y.

Wanted—A good machinist to contract to erect engines in quantities, also another to do the tool work on same by contract. For further information address Box 80, American Machinist.

Wanted—Mechanical engineer of experience and education, posted on engine work, cranes and tools. Good salary and permanent position for competent man. Address Box 82, American Machinist.

Wanted Position as supt. or experimenter; thoroughly understands designing labor saving devices and handling of men. A 1 refs. from those whom I have had business with. Box 83, Am. Machinist.

Wanted—By competent man, position as superintendent, head draftsman or general foreman for machine shop and foundry; Washington Territory preferred; age, 40. Address Box 74, Am. Machinist.

Wanted—Situation by young man as draftsman in architect or patent solicitor's office. Confined to western country; 3 years' exp. with patent solicitor, W. H. Power, Arizona Lumber Co., Flagstaff, A. T.

Wanted—General foreman for machine shop, with practical experience, and accustomed to handle men, capable of getting out correct estimates of all kinds of work; must be energetic, strictly sober, and attentive to business. Box 81, American Machinist.

Wanted—Position as mech. draftsman or assistant to same by tech. grad.; 8 years' exp. in drawing room and shop on variety of work, principally mach. tools. Especially qualified to start up and run a drafting office with system and economy. Best references. Q. E. D., American Machinist.

A thoroughly responsible first-class machinist and engineer will be open for engagement April 15. Have held present position as machinist and chief engineer for four years. Unquestionable refs. from present and past employers; correspondence solicited; satisfaction guaranteed. Chief Engineer, Am. Machinist.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Crescent steel tube scrapers are unquestionably the best. Crescent Mfg. Co., Cleveland, O.

Crescent boiler tube cutter, for setting new and removing old tubes. Crescent Mfg. Co., Cleveland, O.

Light and fine machinery to order; Foot Lathe. Catalogue for stamp. E. O. Chase, Newark, N. J.

August C. Christensen, 24 State St., N. Y., Consulting Engineer. Designs of all kinds of Machinery.

Turned and Highly Polished Iron and Steel Shafting a specialty. Merwin McKaig, Cumberland, Md.

For Sale—Second-hand 72" mill for boring only; good order. A Garvin tapping machine, new. A. L. Henderer, Wilmington, Del.

Pattern makers should send to W. H. Denney, Lancaster, Pa., for circular of Self-adjusting Handscrews. Saves time and labor.

An original and sure receipt for tempering and making Fine Drills. Two cent stamp for terms. I. H. Bartholomew, Northford, Conn.

For Sale—2nd-hand engine 16x36 in., 12 foot band wheel & Judson governor, all in good repair, $300. Geo. Strecker & Co., Marietta, Ohio.

Engineers wanted to send their addresses and receive free a 25 cent book, "Hints and Suggestions for Steam Users." Thos. Ordish, 1723 S. 7th st., Phila., Pa.

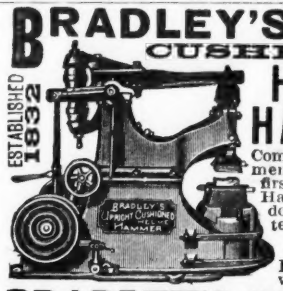
Wanted—Parties selling to steam users and supply houses to handle some good selling specialties on commission. Manufacturer, American Machinist.

How to remove and prevent scale in steam boilers at a cost of ten cents a week. Send postal for circular to Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa.

Wanted—To buy second-hand lathes, planers and shapers of all sizes; must be cheap and in good order. Fosdick & Plucker, 6th and Culvert Streets, Cincinnati, O.

Wanted—One or two first-class machinists with about $3,000, to engage with party having same amount of money, in the manufacture of Iron Planers. Only those wanted having practical experience in building these machines. None others need apply. New Design, care American Machinist.

BRADLEY'S UPRIGHT CUSHIONED HELVE HAMMER



Combines the best elements essential in a first-class Hammer. Has more good points, does more and better work and costs less for repairs than any other Hammer in the world.

BRADLEY'S HEATING FORGES.

With a manufacturing experience of over half a century, we recommend these machines to be the best, simplest, most durable and combining all the essential elements. For hard coal or coke. Indispensable in all shops to keep Bradley's Cushioned Hammers and men fully employed and reduces cost of production.

Pat. Aug. 30, 1887.
BRADLEY & CO.
SYRACUSE, N. Y.
98 Sudbury St., Boston, Mass.
63 Murray St., New York.

IF YOU WANT A STRONG, ECONOMICAL
ENGINE
EITHER HORIZONTAL OR VERTICAL,
For Steady Every Day and All Night Service and at a Low Price, Write to
COOKE & CO., 22 Cortlandt St., New York.
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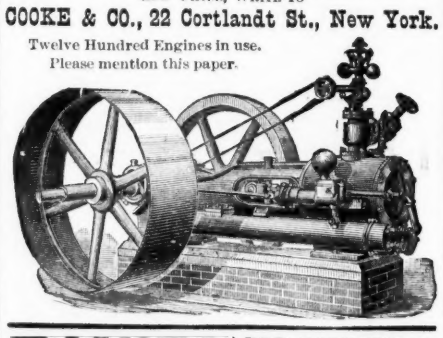

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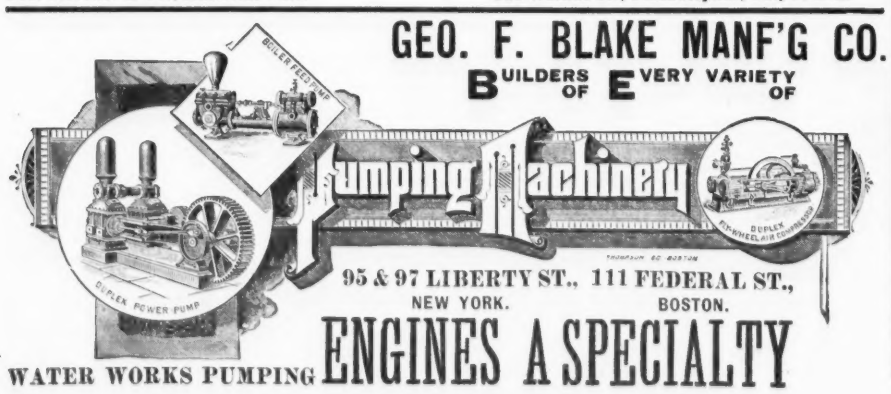

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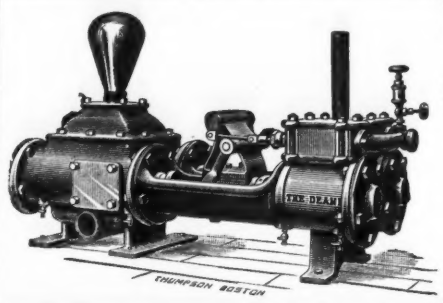

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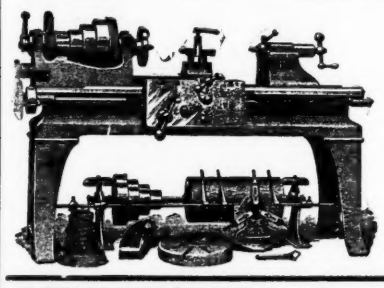

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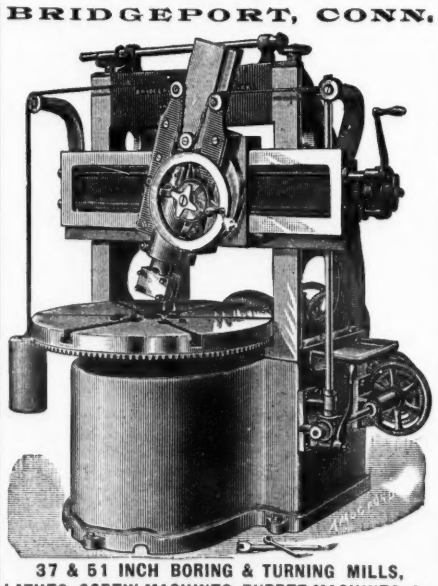

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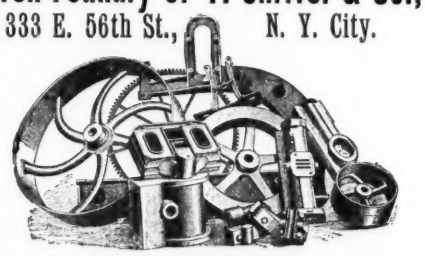

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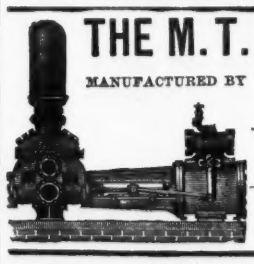

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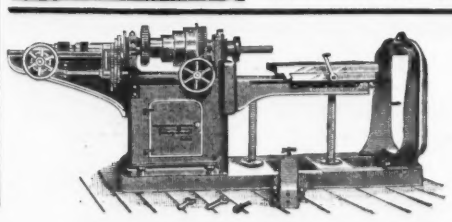

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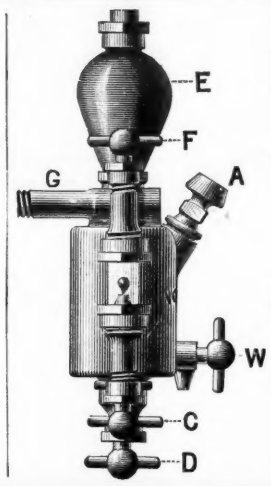

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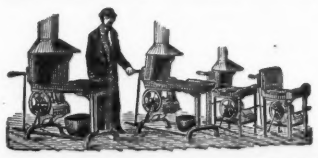

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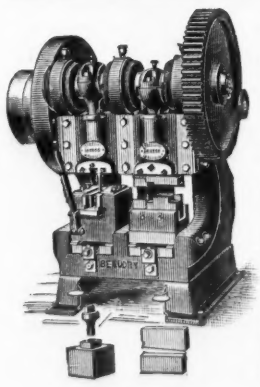

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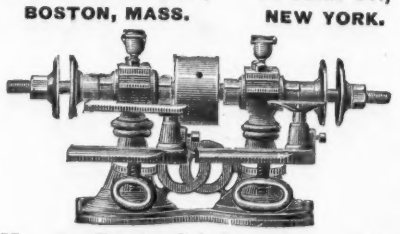

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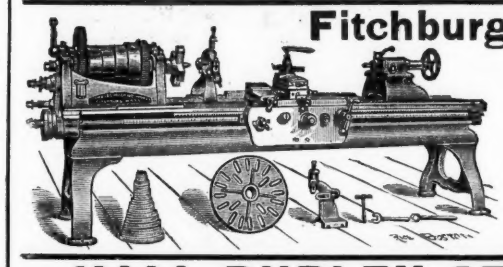

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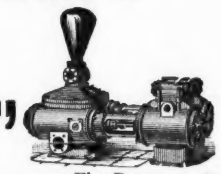

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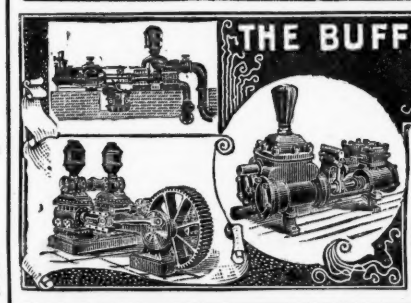

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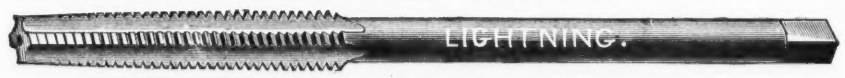

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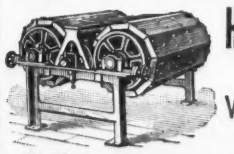

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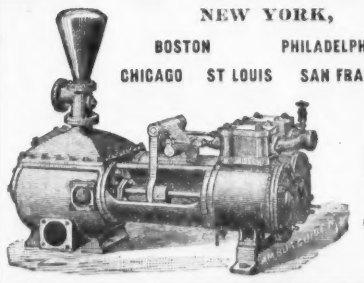

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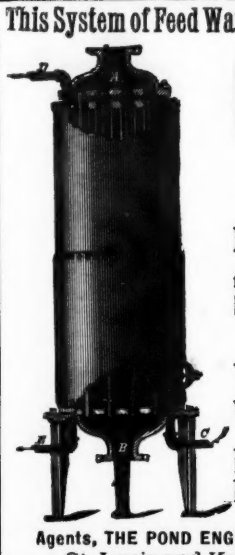

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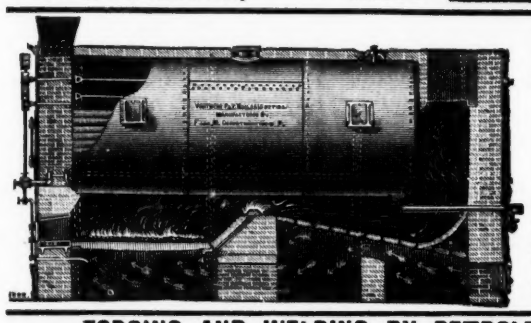

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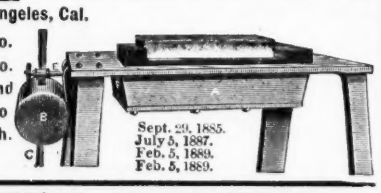

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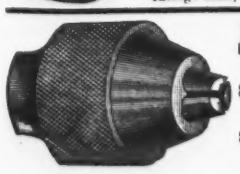

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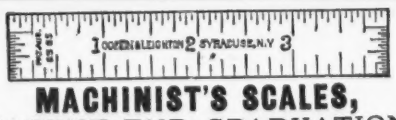

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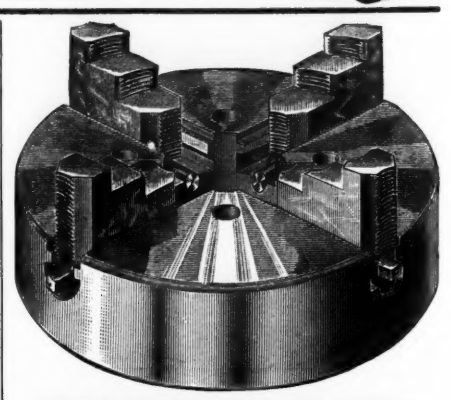

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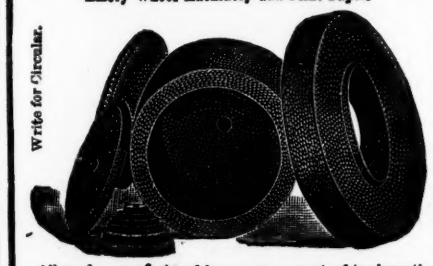

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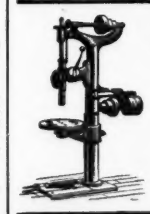

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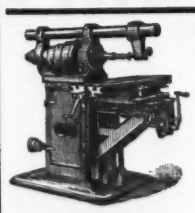

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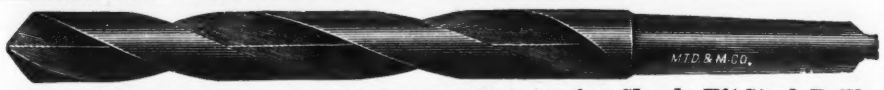

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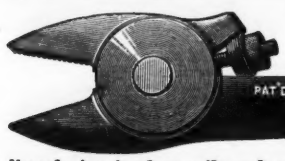

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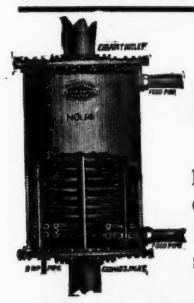

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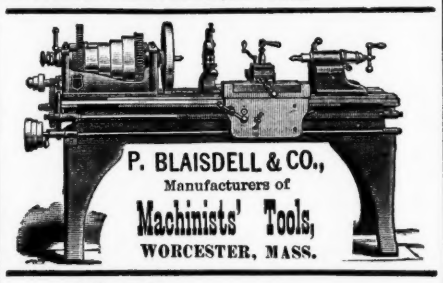

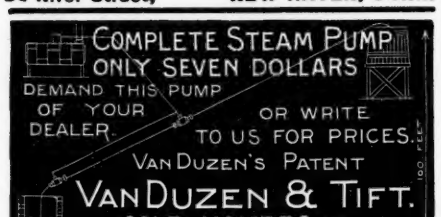

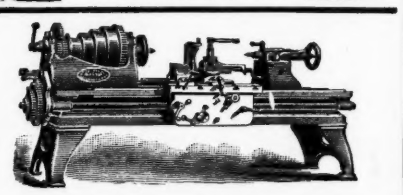

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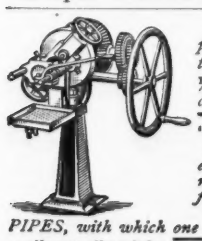

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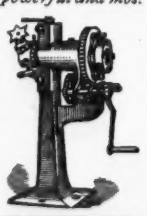

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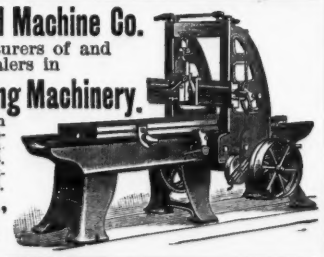

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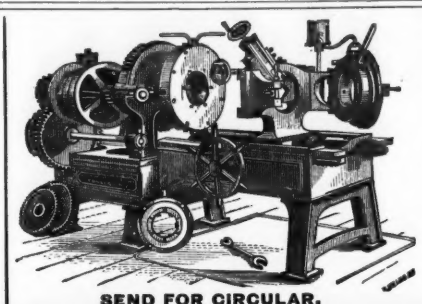

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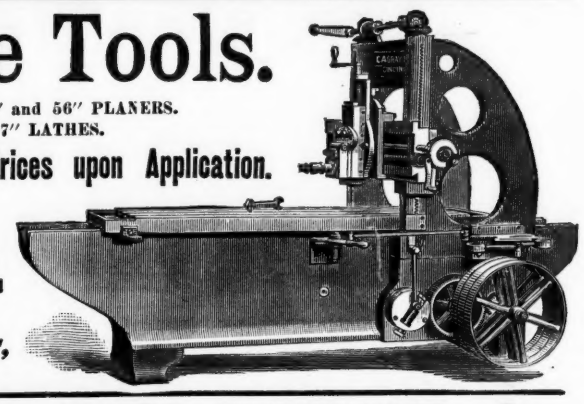

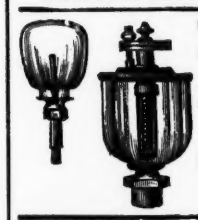

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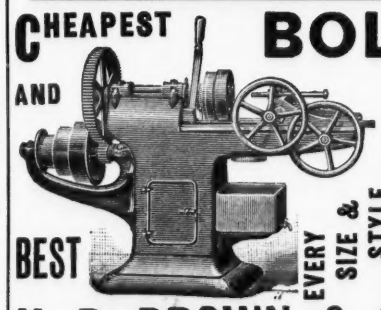

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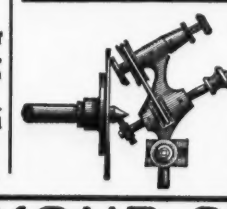

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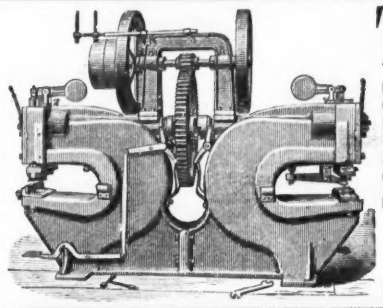

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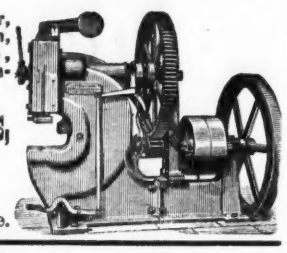

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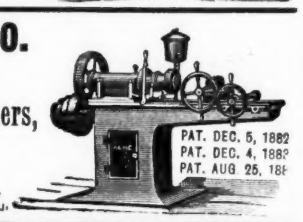

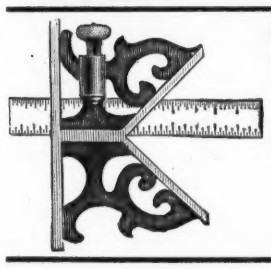

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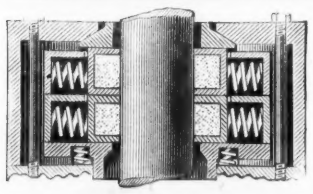

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To stimulate the inventive genius of the Machinists of the United States, we propose to pay the above amount on Sept. 1st, 1889, to the machinist submitting to us **the most original and desirable improvement not already applied to our Standard Engine Lathes.**

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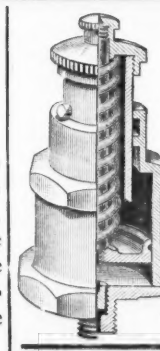

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SAVES ALSO IN LABOR, AND COST OF COTTON-WASTE. PREVENTS DRIPPING AND SPATTERING.
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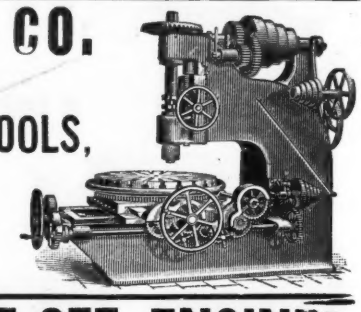

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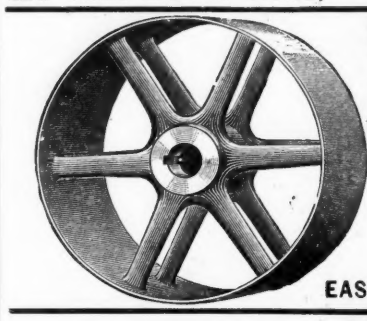

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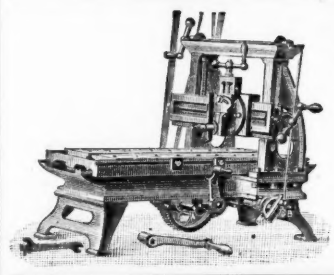

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Weight of Platen 100 lbs.
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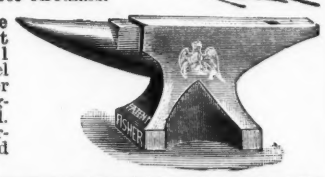

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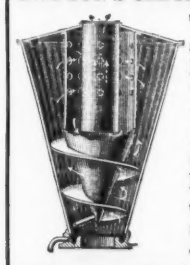

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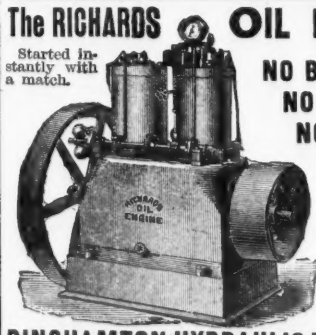

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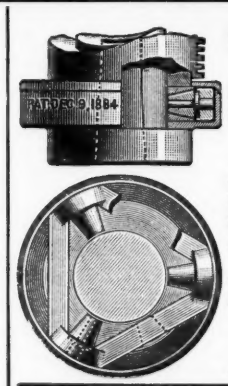

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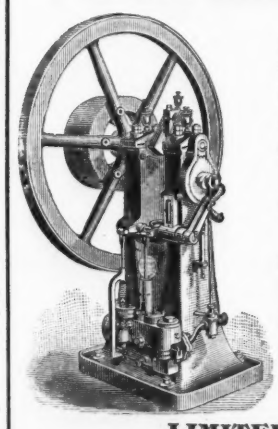

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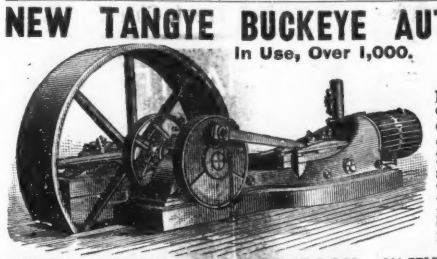

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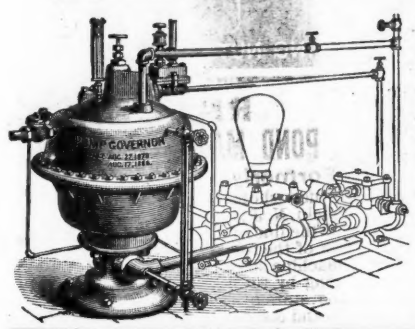

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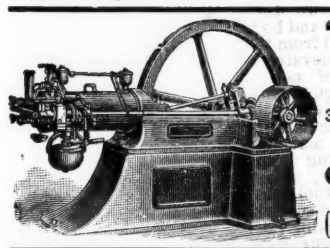

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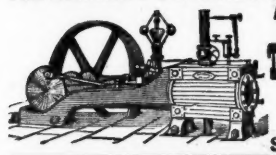

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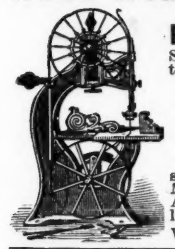

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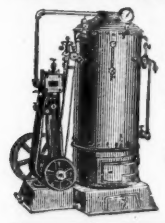

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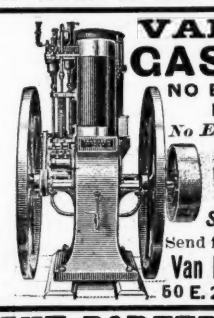

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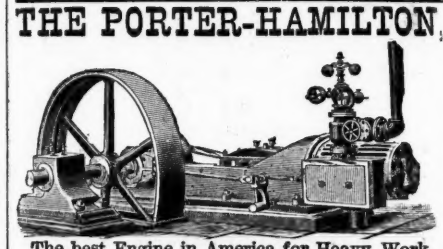

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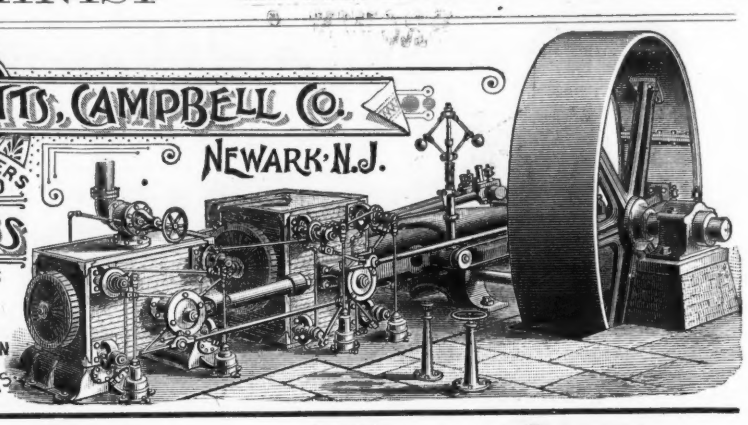

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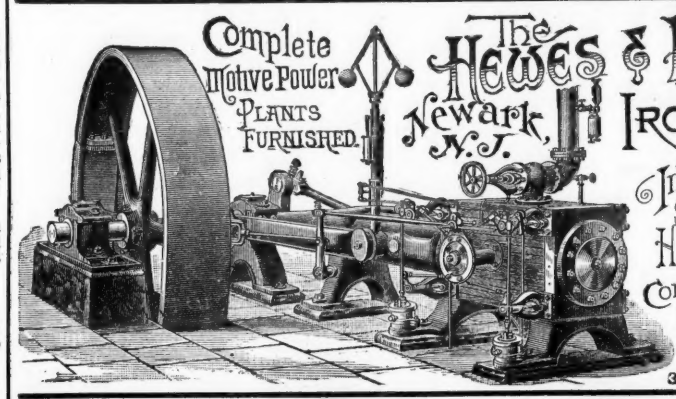

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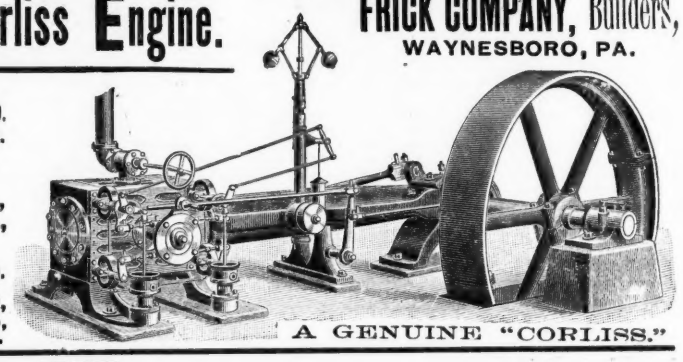

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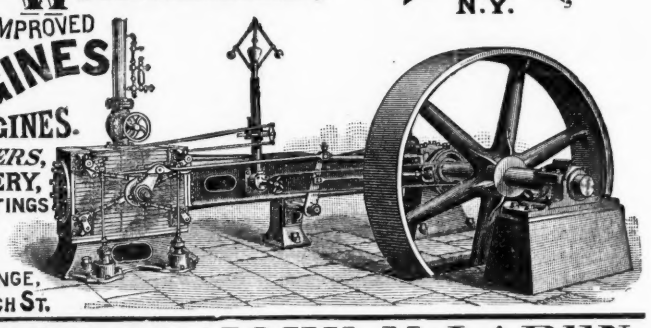

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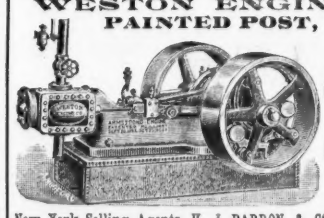

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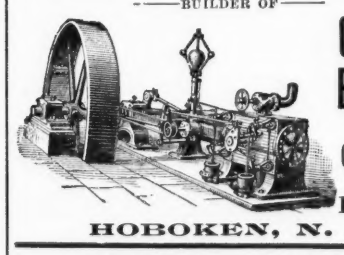
BUILDER OF

CORLISS Engines,

AIR Compressors and BOILERS.



HOBOKEN, N. J.

SECOND-HAND Machine Tools

(TAKEN IN TRADE FOR NEW.)

One Sellers Iron Planer, planes 42 in. wide, 36 in. high and 12 ft. long, light pattern, in good running order.

One Gleason Iron planer, 42 in. by 42 in. by 10 ft., with two heads on the cross rail; is in first rate condition.

One Lathe and Morse Planer, 24 in. by 24 in. by 6ft. In good condition.

One Brettell Iron Planer, 24 in. by 24 in. by 6 ft. In first rate condition.

One Wheeler Planer, planes 26 in. wide, 24 in. high, and 6 ft. long. In first rate condition.

Also very large stock of new Iron Planers, and new and second-hand Engine Lathes.

HILL, CLARKE & CO.,

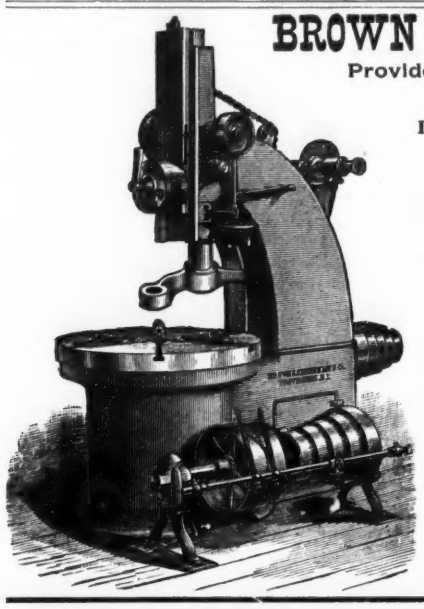
156 OLIVER ST.,

BOSTON, MASS.

BROWN & SHARPE MFG. CO.,

Providence, R. I., Manufacturers of

MACHINERY AND TOOLS.



Description of No. 2 Vertical Chucking Machine.

Patented August 4th, 1885.

With this Machine from two to four times as much work can be accomplished in a given time as can be done upon an Engine Lathe, and in a much superior manner, the work being more easily trued and fastened in place than upon any machine having a horizontal spindle, and the different tools in the turret-head easily brought into operation in succession, while, from the perpendicular position of the same, the chips fall through the center of spindle of revolving table to the floor, causing no trouble by clogging of reamers, &c.

It has the Capacity to take a pulley 36 in. diam., 16 in. face, and hub of 12 in. in length, and to bore a 4-in. hole in same, making two or three cuts, and finish by reaming, without removing the tools or work.

The Revolving Table is driven by a 5-step cone for 3 in. belt, and geared 6 to 1. Steps of cone so graded as to make cutting speed uniform for 5 different diameters of holes.

The Turret has 4 holes 1 3-4 in. in diameter, and is securely clamped in position. An adjustable dog allows the locking pin to be withdrawn at any part of its upward motion.

The Turret Slide has a movement of 21 in., and an automatic feed which can be easily and quickly changed from the finest ever needed to the coarsest required, it has quick return by hand, and is counterbalanced by a weight inside of column.

Weight, 4,400 lbs.

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Manufacture **LATHES** of Various Sizes

AND OF THE FOLLOWING KINDS.

Hand, Engine for Turning and Screw Cutting, Cutting Off, Gap Bed, Pulley Turning and Boring, Turret-Head Engine and Chucking, Hand Wheel Rim Turning, Spinning, Grinding, Pattern Making, &c.

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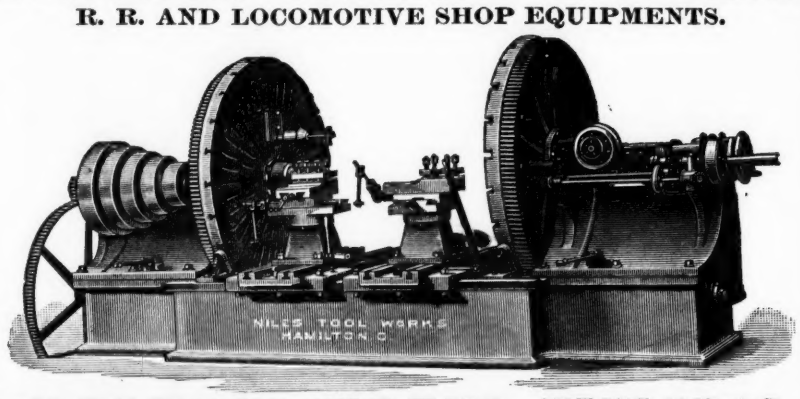

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HAMILTON, OHIO.

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THE BILLINGS & SPENCER CO. HARTFORD CONN.

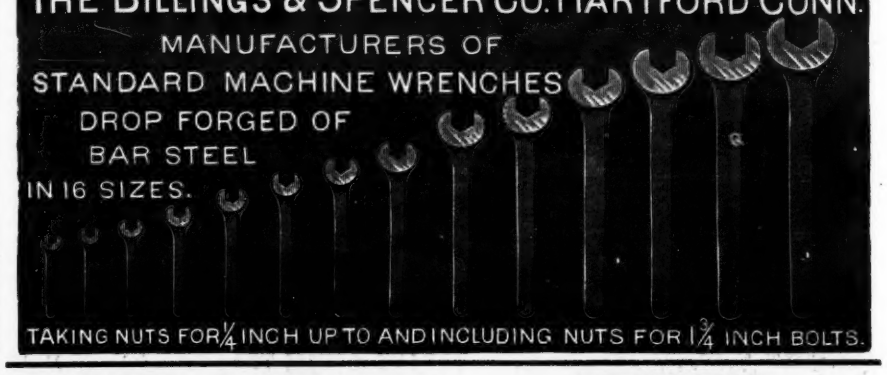
MANUFACTURERS OF

STANDARD MACHINE WRENCHES

DROP FORGED OF

BAR STEEL

IN 16 SIZES.



TAKING NUTS FOR 1/4 INCH UP TO AND INCLUDING NUTS FOR 1 3/4 INCH BOLTS.

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MACHINE TOOLS CLEVELAND, OHIO.

For IRON and BRASS WORK.

Illustrated Catalogue on application.

REMOVAL.

THE POND MACHINE TOOL COMPANY,

Formerly of Worcester, Mass.

The new shops of this company are located at Plainfield, N. J., forty minutes' ride from New York city on the line of the Central Railroad of N. J., and consist of the following:

A machine shop 500′ long by 100′ wide; a foundry 250′ long by 90′ wide; also commodious buildings for the storage of sand, coal, coke and pig iron; ample and convenient wash rooms for the men; fireproof two story pattern storage; blacksmith shop; engine and boiler houses. These buildings are detached from the machine shop and foundry. There is an elevated railroad for the convenient distribution of raw materials, and a railroad running through the machine shop for shipping. The whole plant is supplied with the incandescent system of electric lighting.

The machine shop and foundry have overhead traveling cranes running through their entire lengths; also light traveling cranes, which serve every tool, and a number of jib cranes in the foundry and scratch rooms. The foundry has capacity for making the heaviest class of castings.

All our tools are expressly designed for the economical manufacture of heavy machinery for railroad and general machine shop equipment, from new patterns of the latest and best designs.

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JENKINS BROS.' VALVES.

JENKINS

Every valve tested and warranted, all parts interchangeable.
Nothing but best Steam Metal used in the manufacture.
Keyed Stuffing Box and Disc Removing Lock Nut
Is used only in the Jenkins Bros.' Valves.
None are genuine unless stamped with "Trade Mark."
Should you order INSIST on having Jenkins Bros.' Valves.

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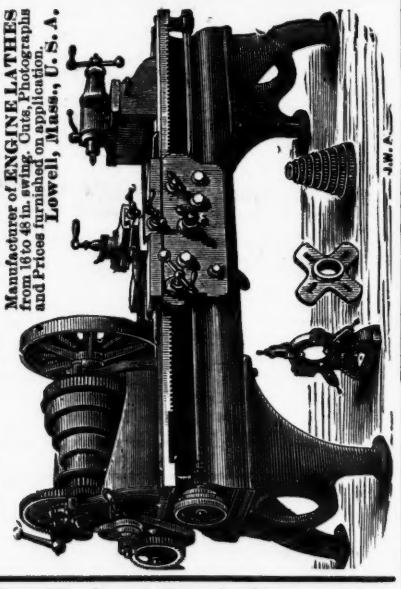
Manufacturer of ENGINE LATHES from 16 to 48 in. swing. Cuts, Photographs and Prices furnished on application. Lowell, Mass., U. S. A.



Gear Wheels and Gear Cutting.—I make g to order, or cut teeth on g blanks sent to me. Of all kinds. Of all sizes to six ft. dm. Small orders or large ones. Fine g or cheap g. Small cast g. Ready made brass g by mail at low prices. Bevel g with perfect planed teeth. Hand Book on g, $1. Facilities complete. Terms reasonable. Send for cat. GEO. B. GRANT, 66 Beverly St., Boston, Mass.

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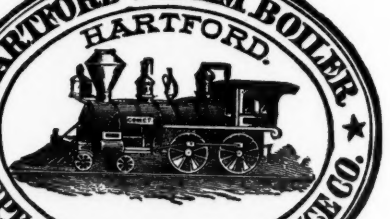

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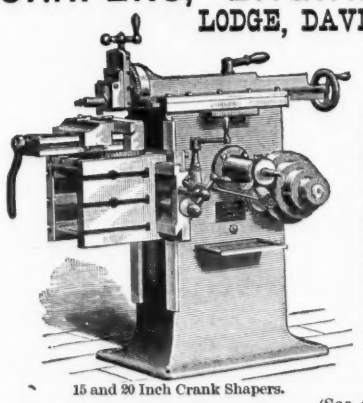

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20 inch Upright Drills. 25 inch Back Geared, and
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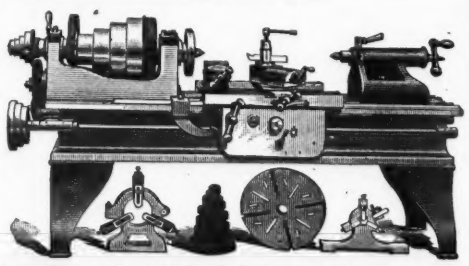
28, 32 and 40 inch Power Feed Drills.



SHAPERS, 15″ and 20″ Crank. 20″, 26″, 32″ Geared.
ENGINE LATHES, 17″, 19″, 21″, 24″, 27″, and 38″.

(See advertisement, page 15.)

Key-Seating Machines and 20 in. Drills

A SPECIALTY.

SEND FOR LIST OF

New and Second-Hand

Lathes, Planers, Drills, or anything in Machinists' Tools or Supplies.

W. P. DAVIS,

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Works at North Bloomfield.

PATENT UNIVERSAL SCREW-CUTTING CENTER DEPTH ANGLE AND

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Fine Machinists' Tools.—**E. Boston, Mass**—Send for Circular

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MACHINE TOOLS.

THE G. A. GRAY CO.,

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See advertisement, page 13.

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EBERHARDTS PATENT DRILL PRESS.

The only one built on **correct principles.**
More **economical** than any we have ever used.
Can do **double** the work. Most convenient.
Best in the market. Much admired.
No trouble or expense for repairs.
Could not ask for anything better.
There may be as good a one made by some one else, but **I have not seen it.**
I feel that **I did wisely** in buying your tool.
We consider it a **model tool** and fills the whole bill.

Below we give the names of a few prominent users of these machines. Their appreciation can be estimated from the number of machines in use.

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Also, Standard Oil Company, Lima, O.
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LIGHT HEAVY WORK.

All sizes ready for quick delivery.

Machines shown in operation by the man'f'rs,

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BUFFALO STEEL FOUNDRY,

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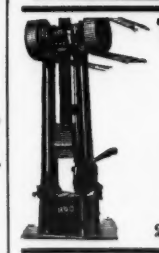

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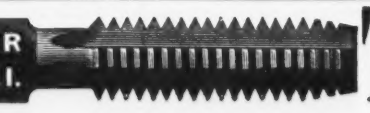

Manufacturer —of— TAPS & DIES